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(12) **United States Patent**
Rodriguez

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(54) **AUTOMATIC DRILLER**

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Related U.S. Application Data

(63) Continuation-in-part of application No. 13/959,912, filed on Aug. 6, 2013, now abandoned.

(51) **Int. Cl.**

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E21B 31/00	(2006.01)
E21B 4/04	(2006.01)
E21B 33/12	(2006.01)
E21B 41/00	(2006.01)
E21B 43/11	(2006.01)
E21B 43/112	(2006.01)
E21B 43/14	(2006.01)
E21B 7/00	(2006.01)

(52) **U.S. Cl.**

CPC ***E21B 31/002*** (2013.01); ***E21B 4/04*** (2013.01); ***E21B 7/00*** (2013.01); ***E21B 33/12*** (2013.01); ***E21B 41/00*** (2013.01); ***E21B 43/11*** (2013.01); ***E21B 43/112*** (2013.01); ***E21B 43/14*** (2013.01); *E21B 2023/008* (2013.01)

(58) **Field of Classification Search**

CPC combination set(s) only.
See application file for complete search history.

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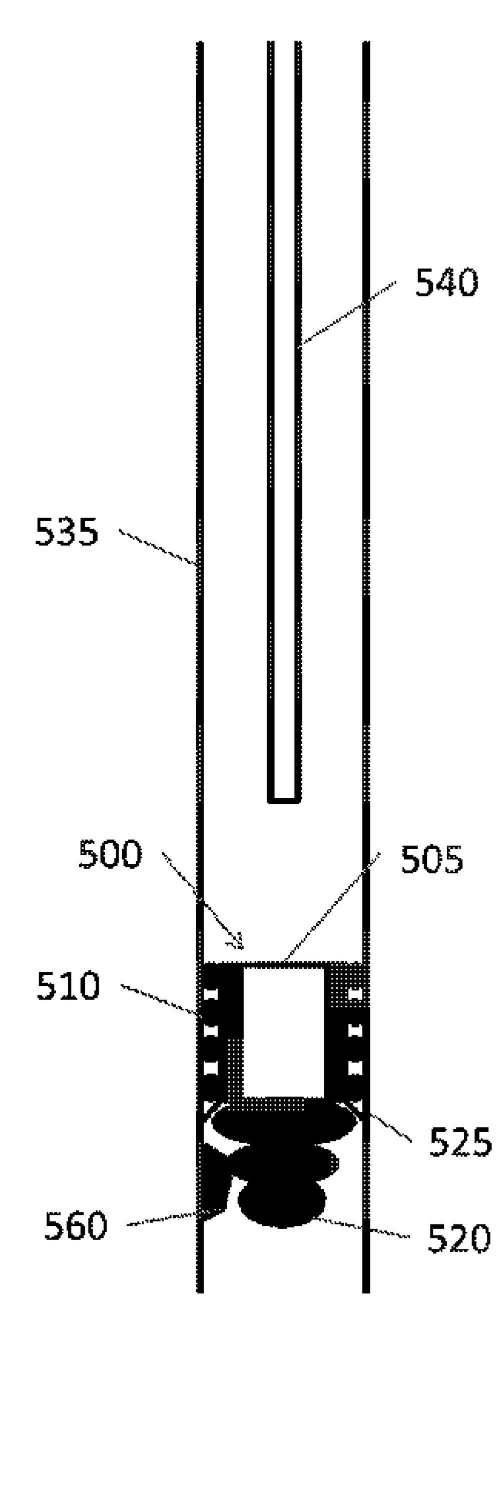
(57) **ABSTRACT**

An automatic drilling apparatus having a tool body, a motive device connected to the tool body, and a drill bit connected to the tool body. The apparatus also includes a setting tool connected to the body, at least one sensor disposed on the tool body, and a computer disposed in the tool body, wherein the computer is configured to actuate the motive device, the drill bit, the setting tool, and the at least one sensor.

20 Claims, 30 Drawing Sheets



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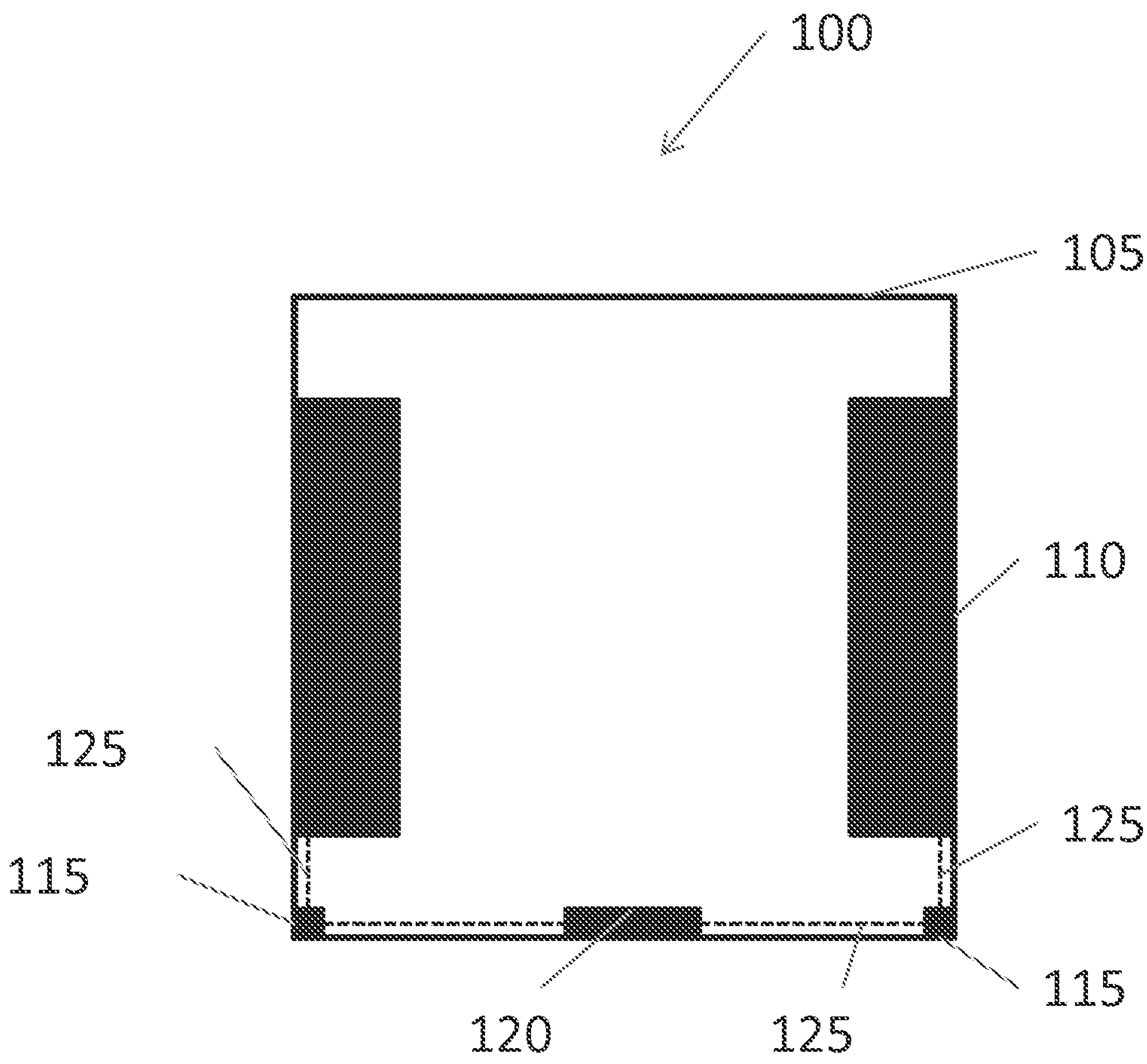

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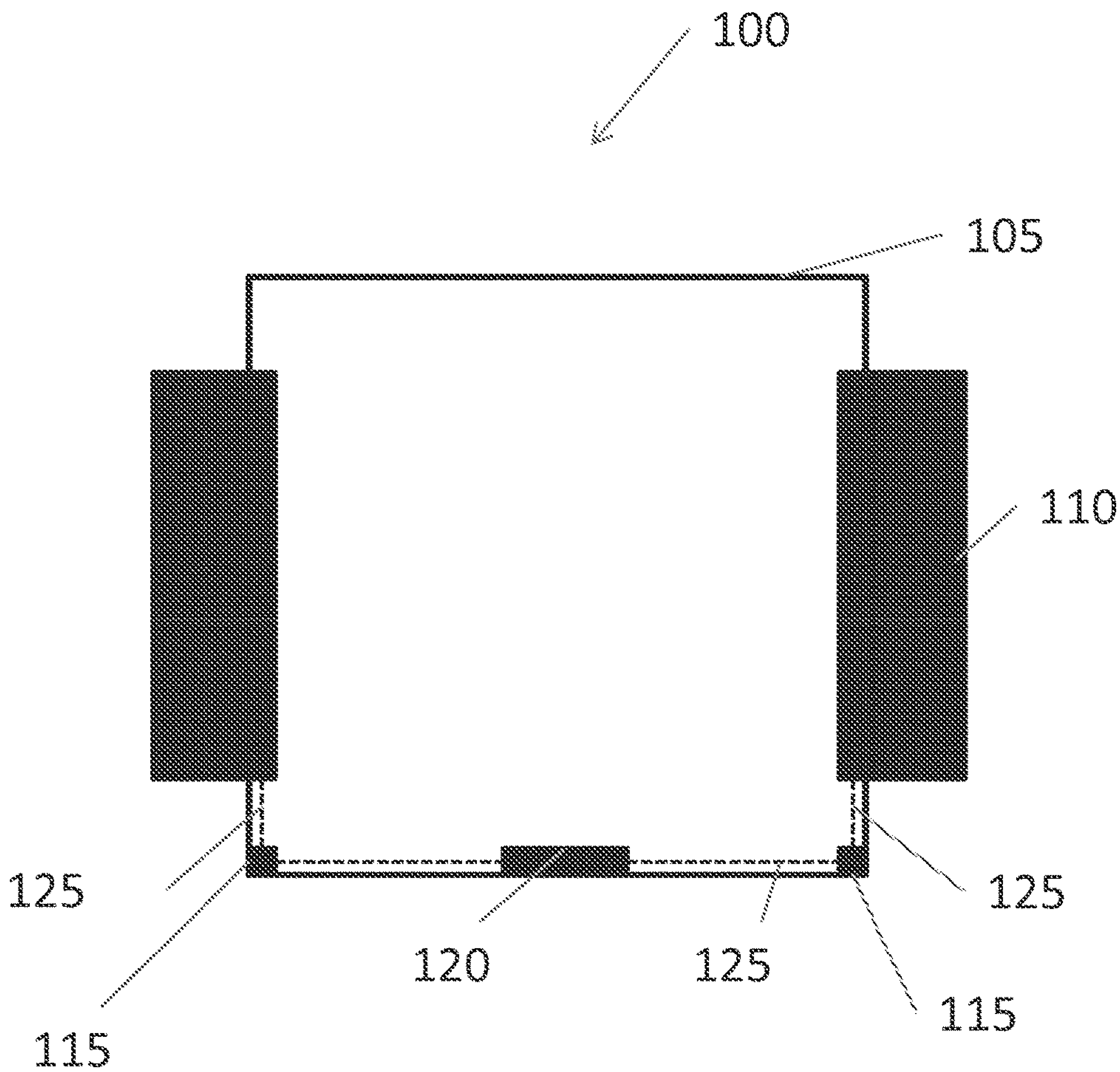

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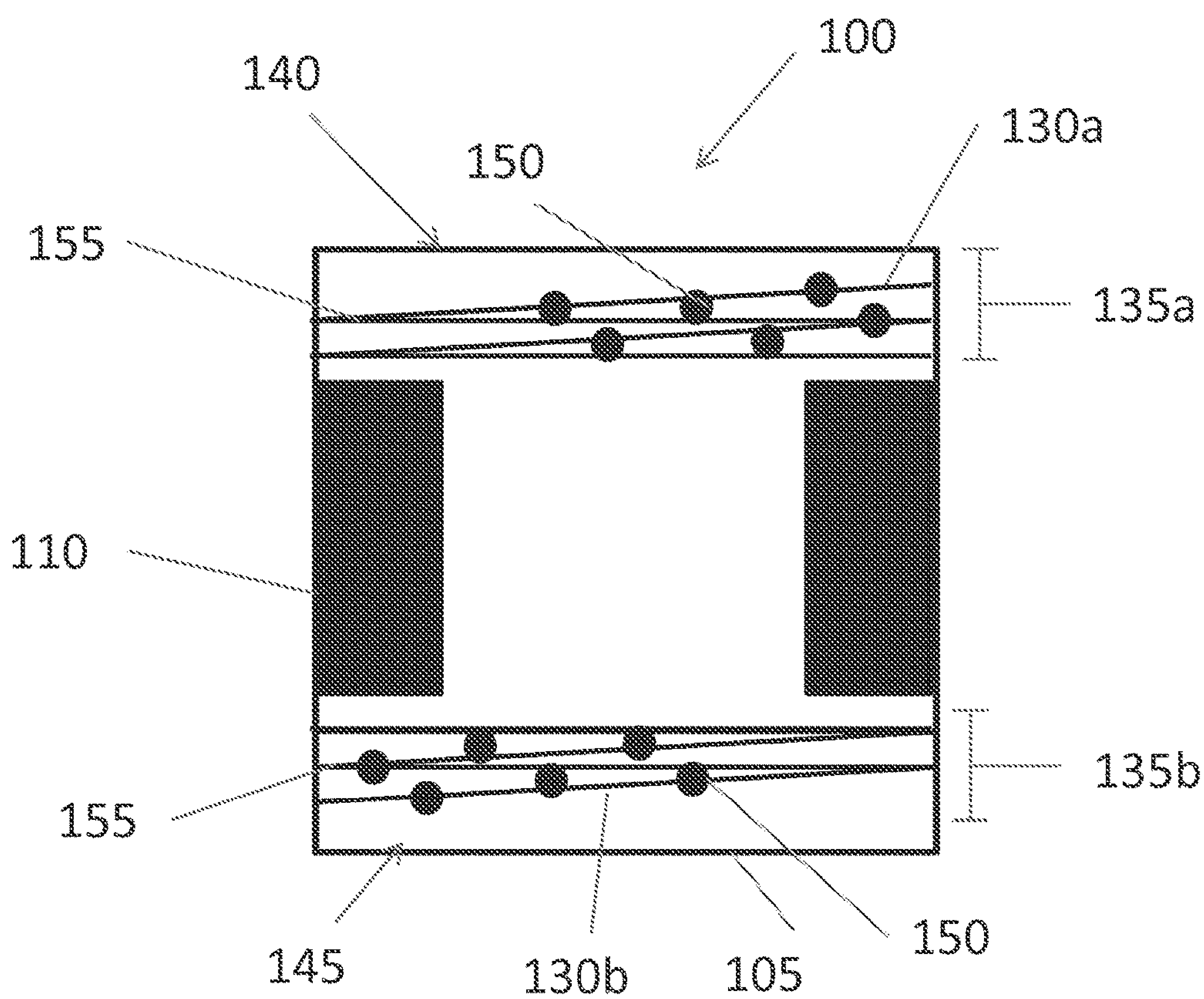

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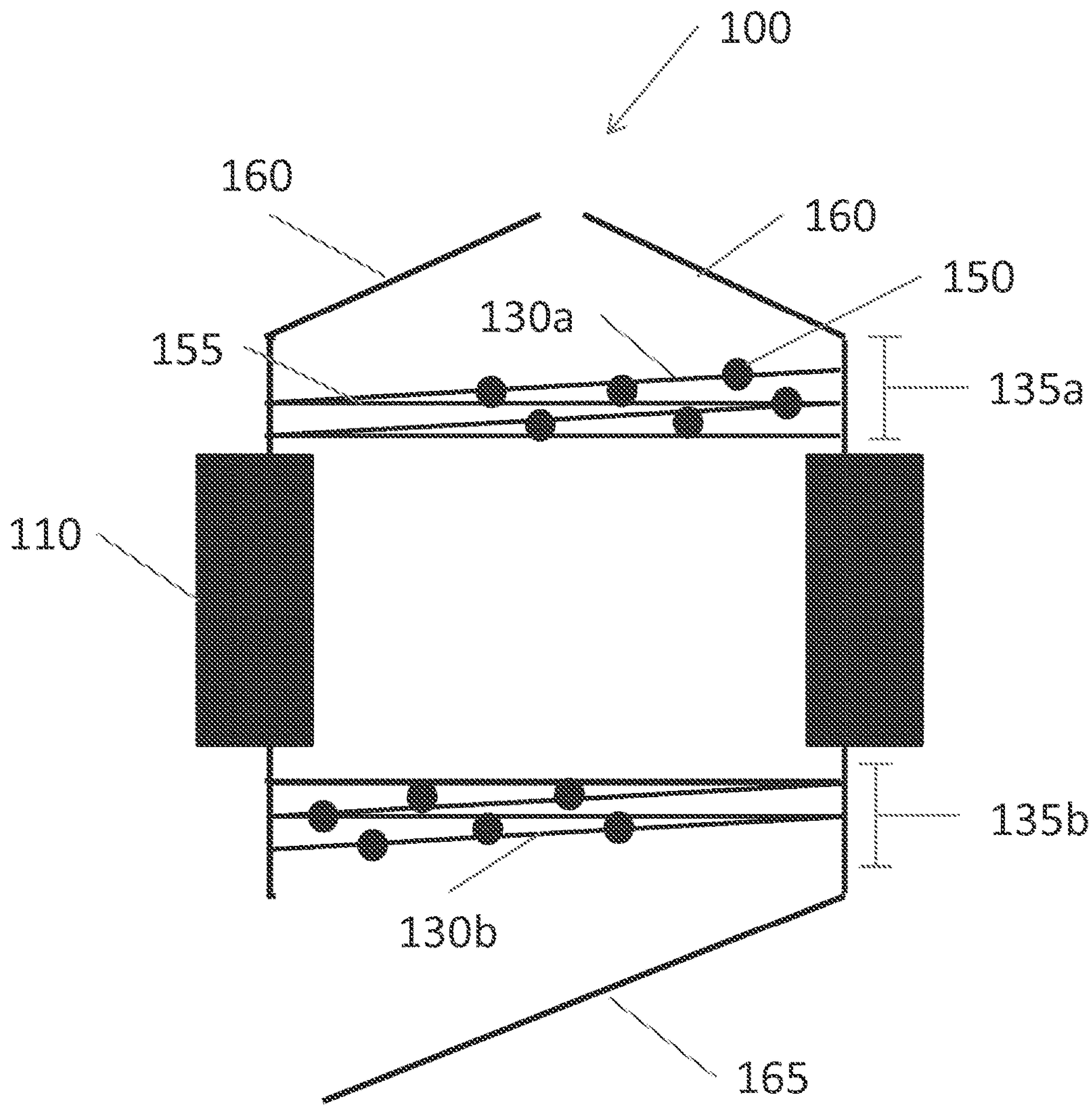

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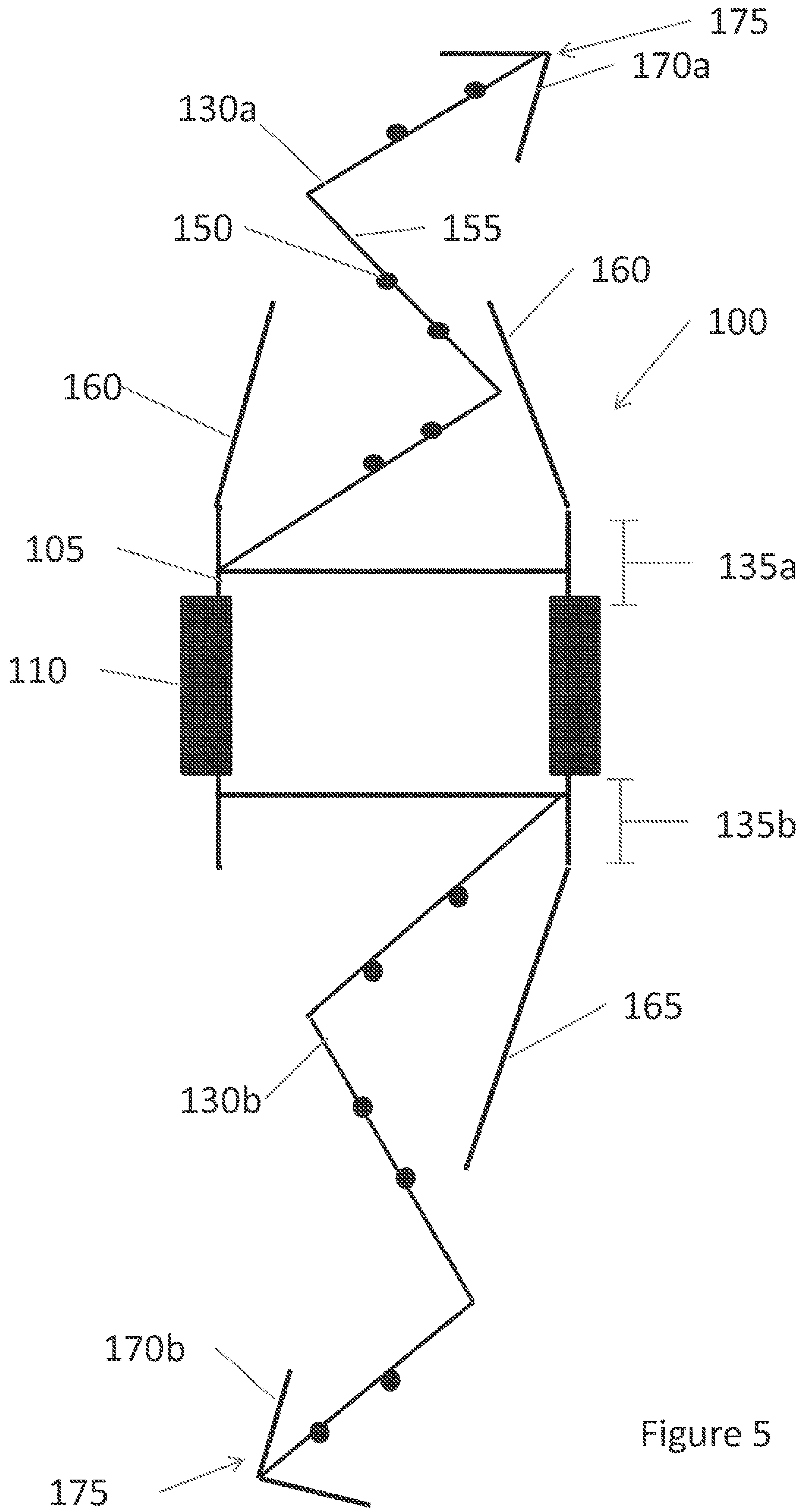
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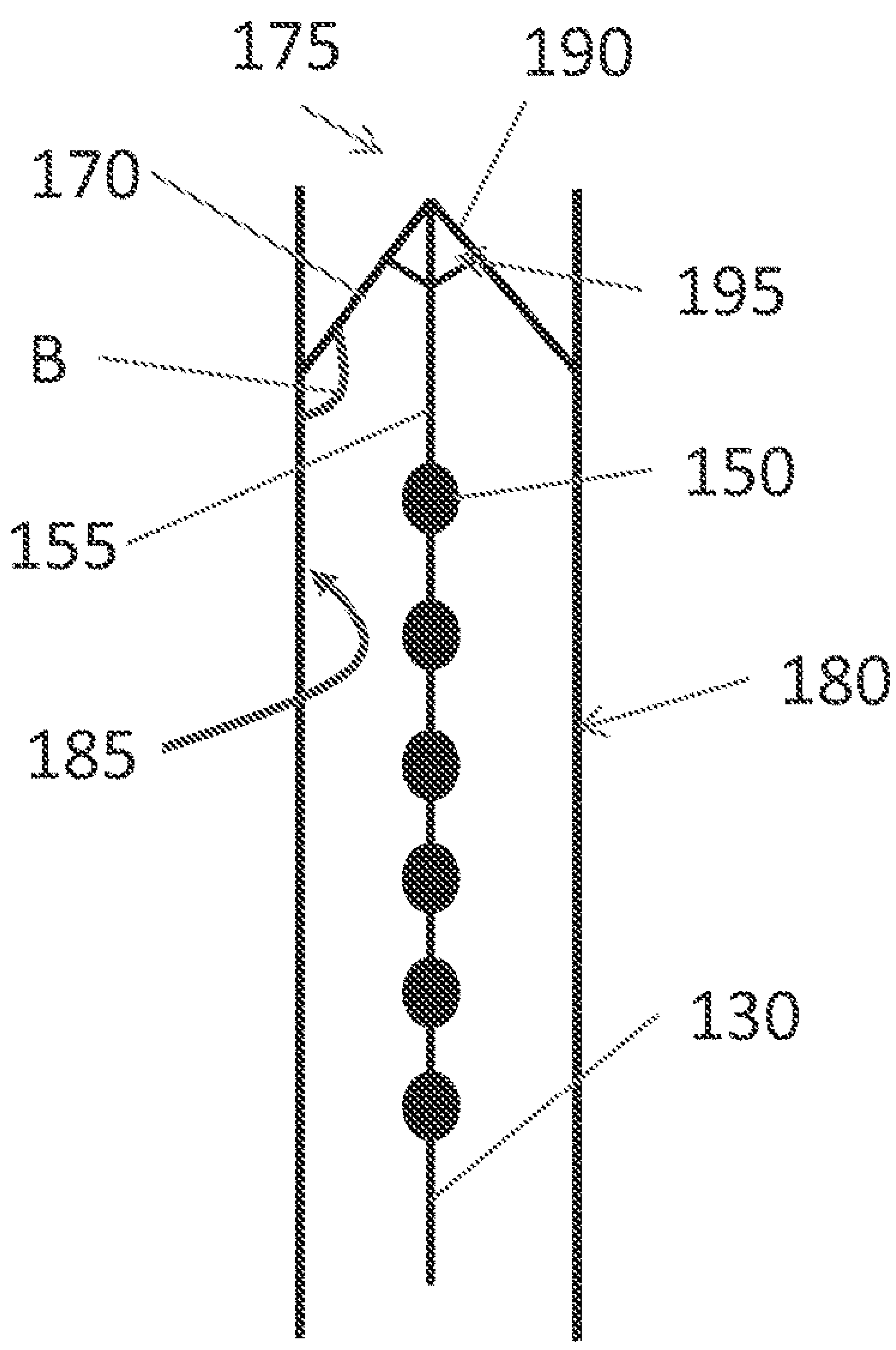

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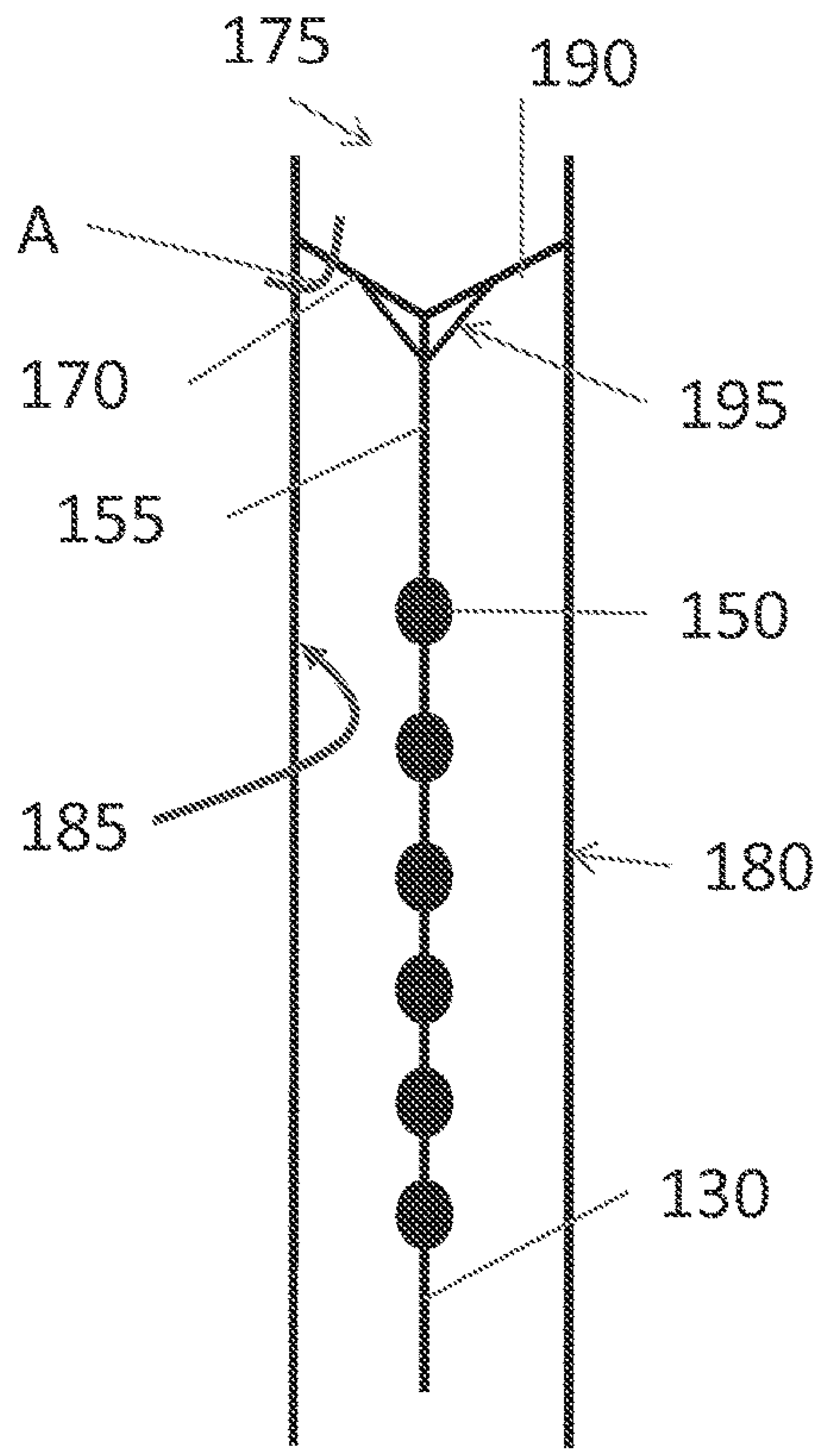

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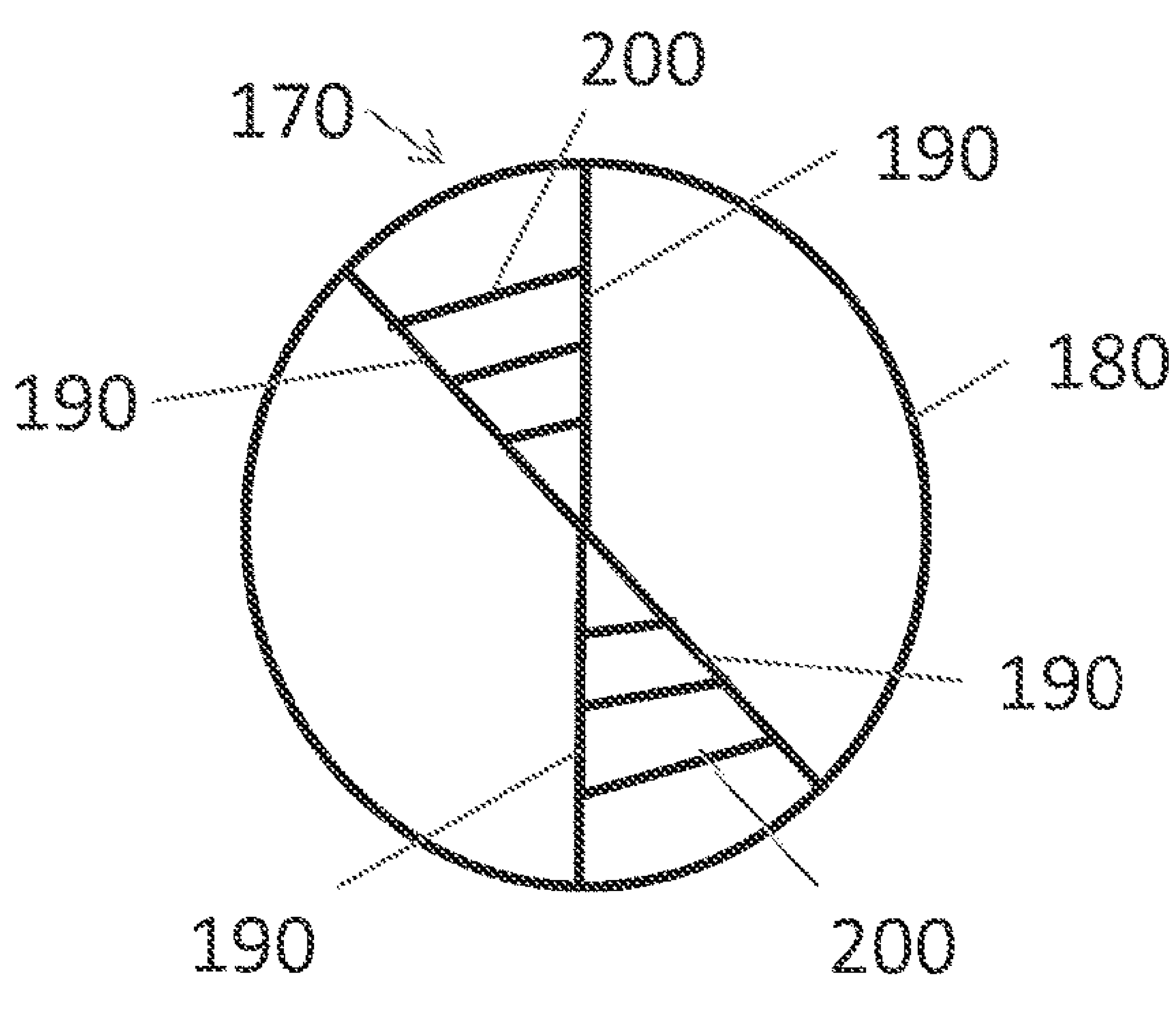

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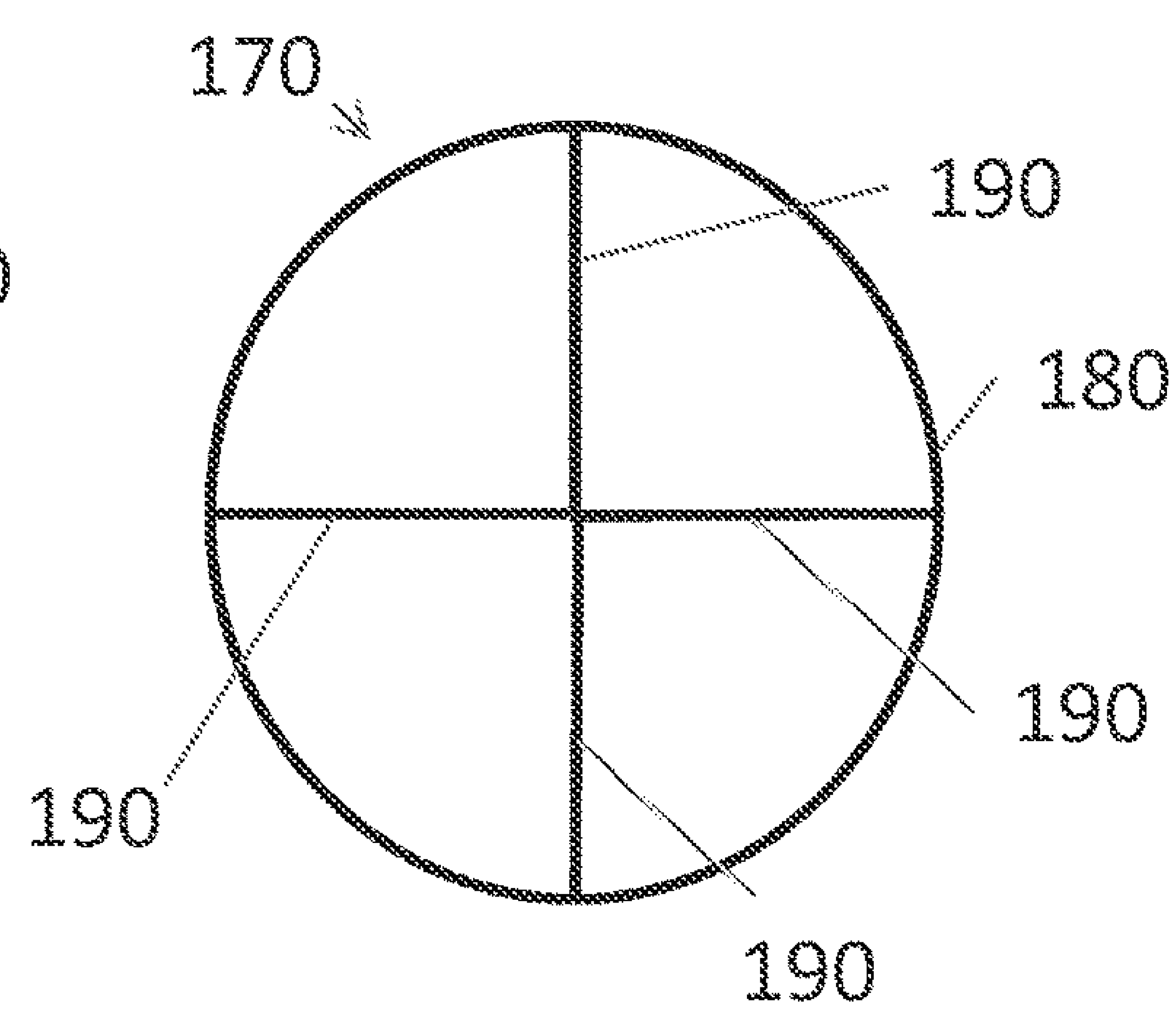

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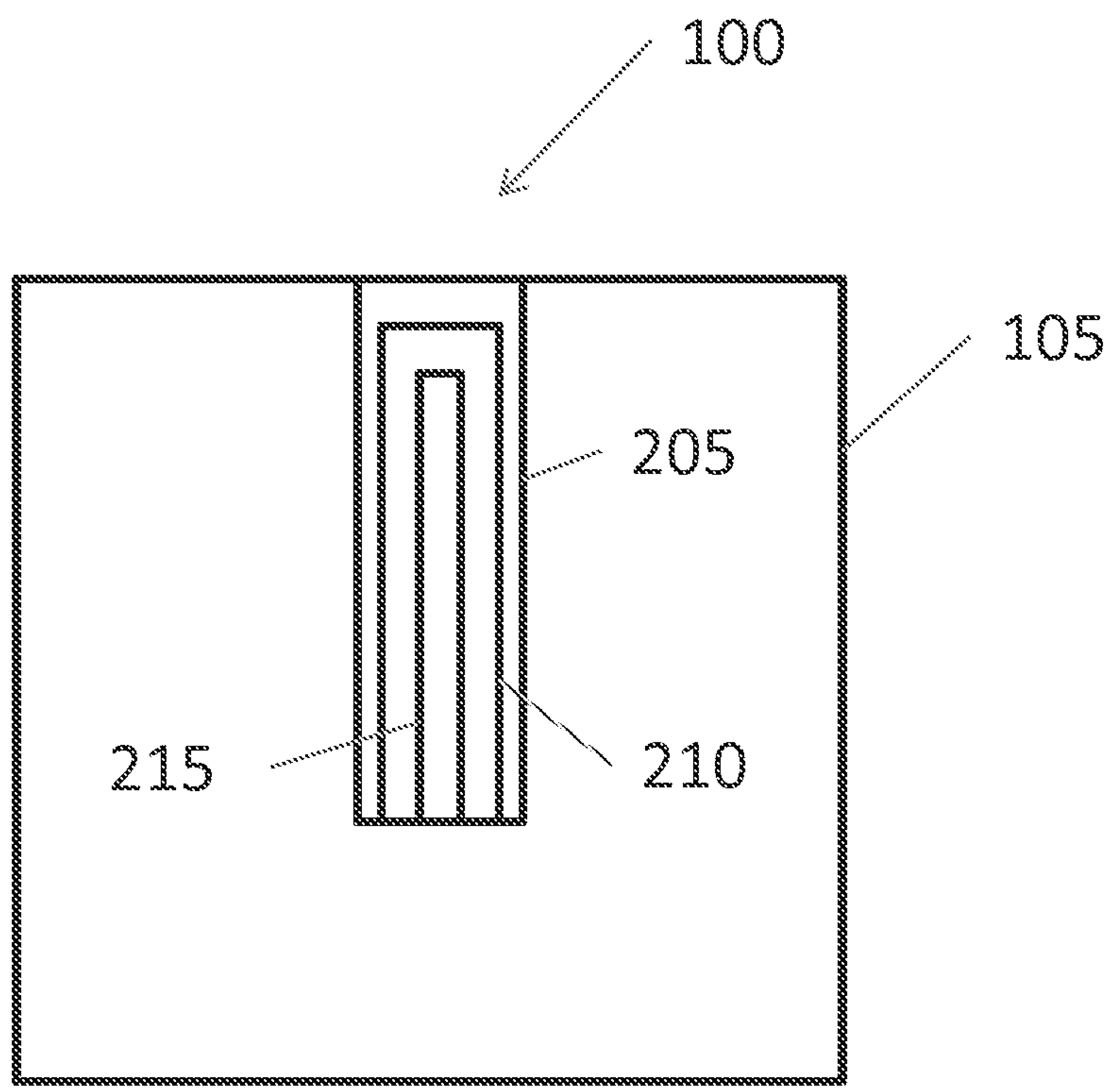

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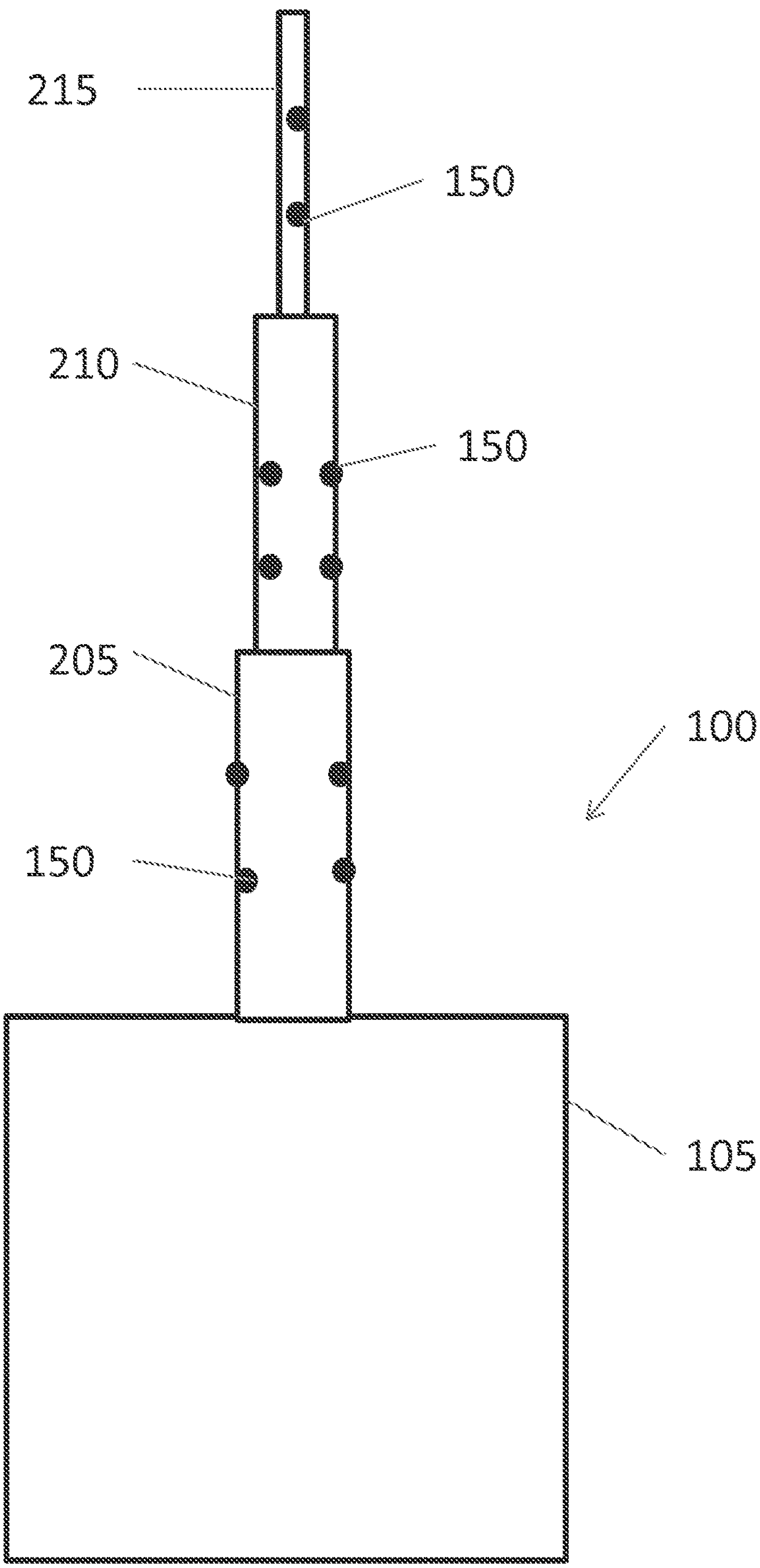

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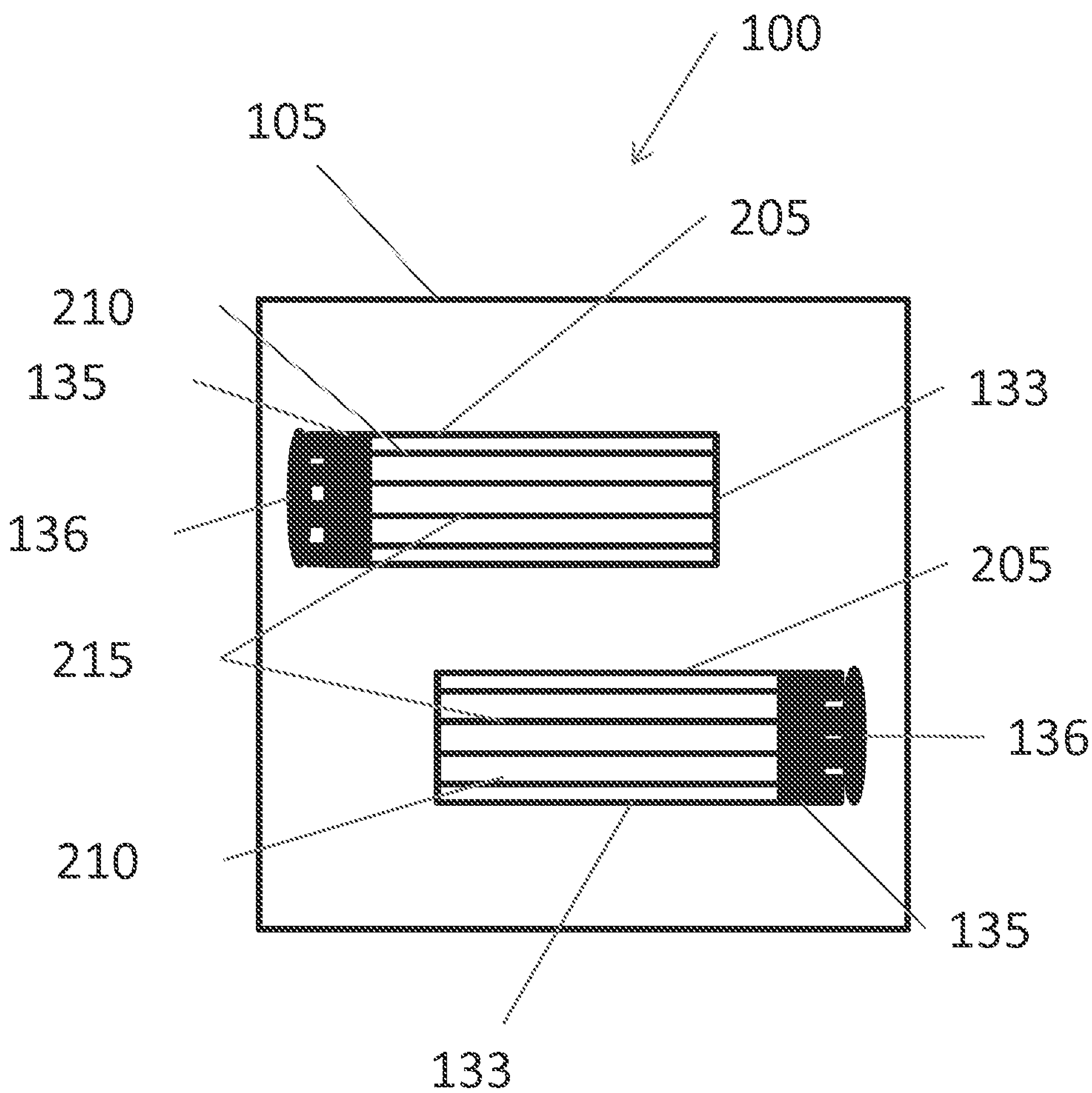

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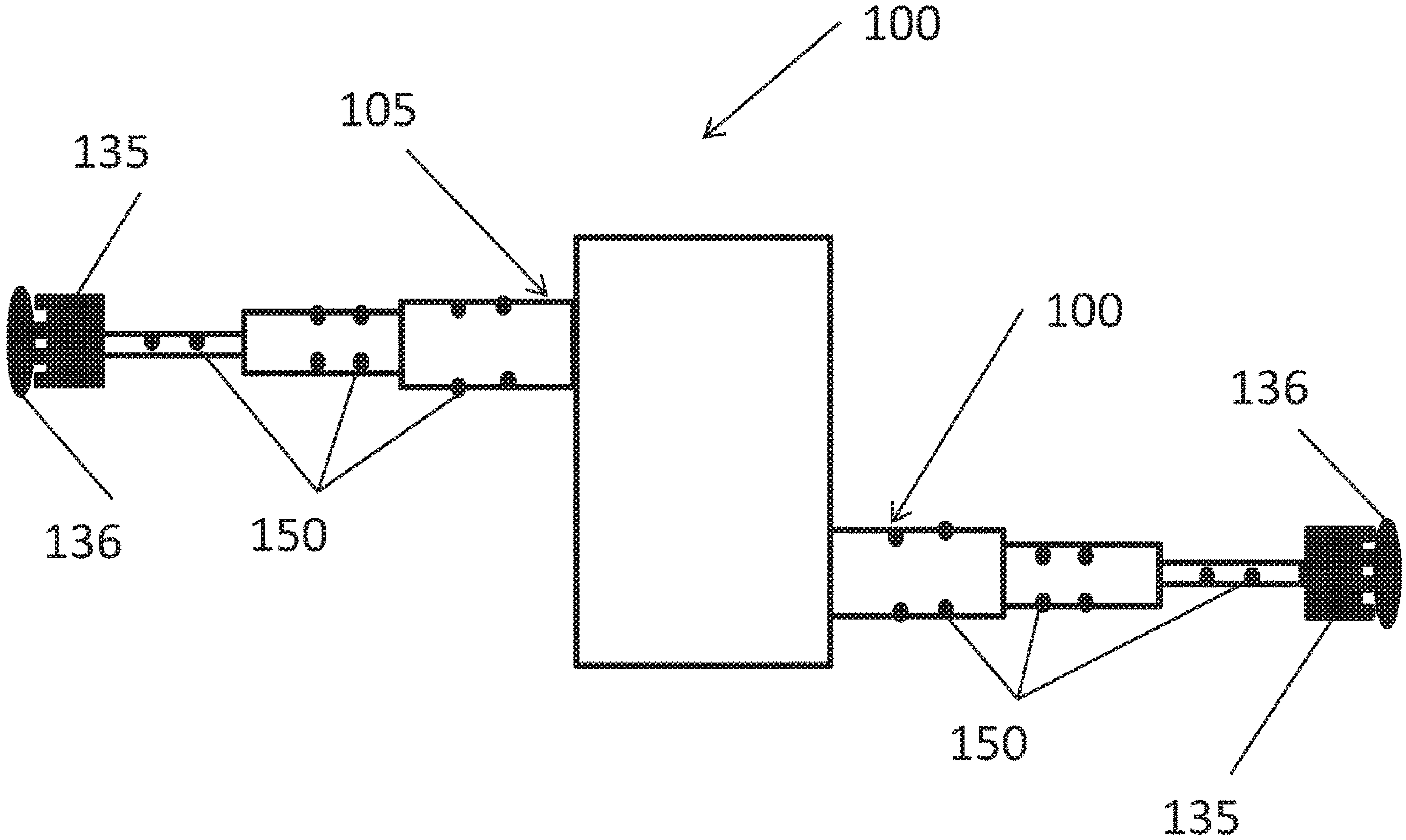

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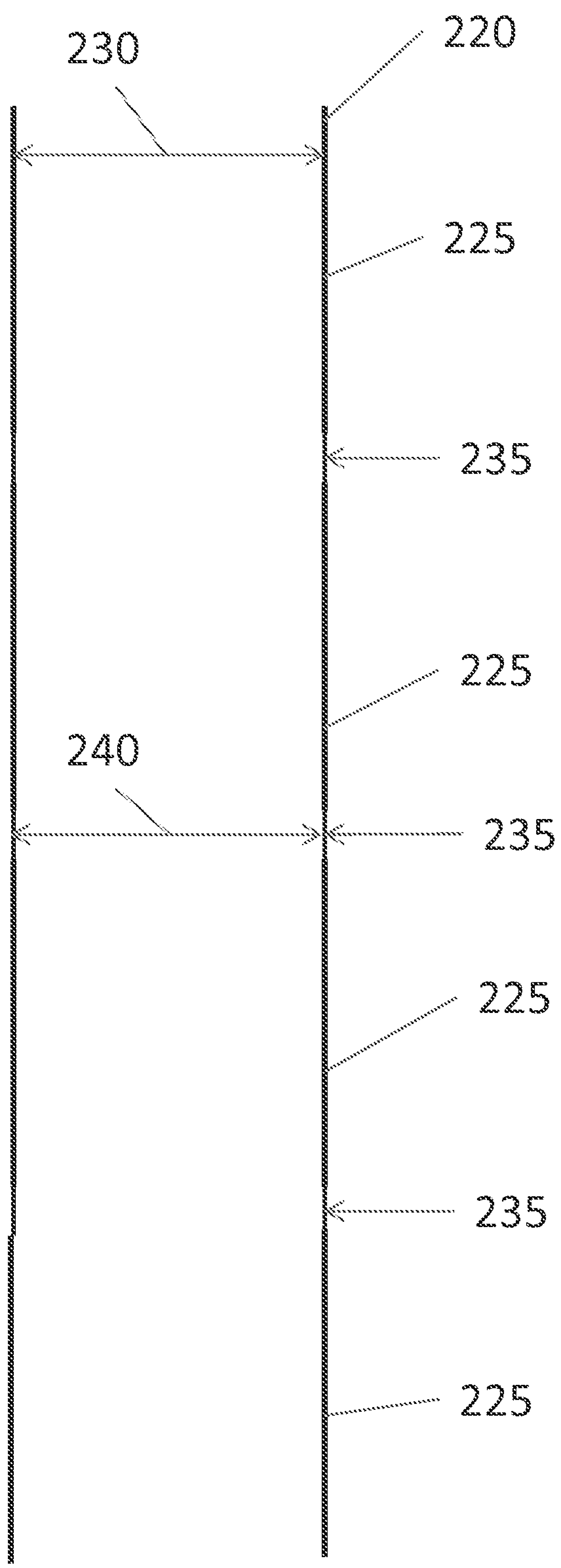

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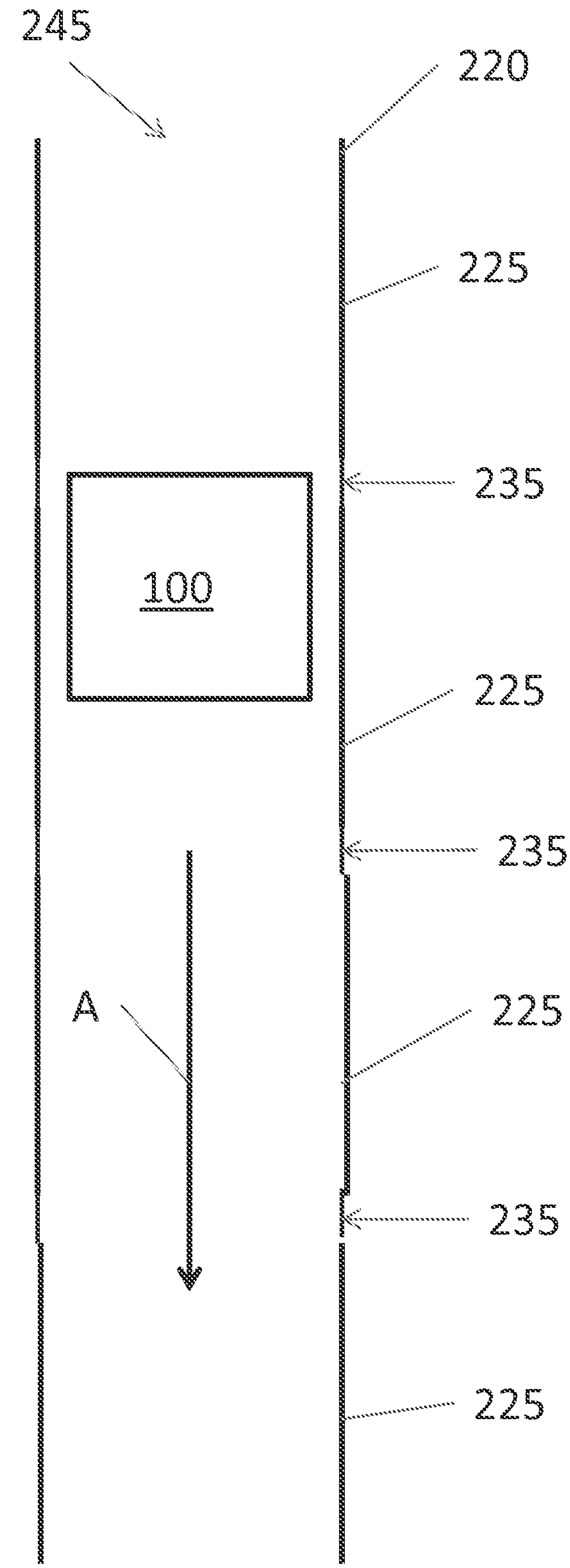

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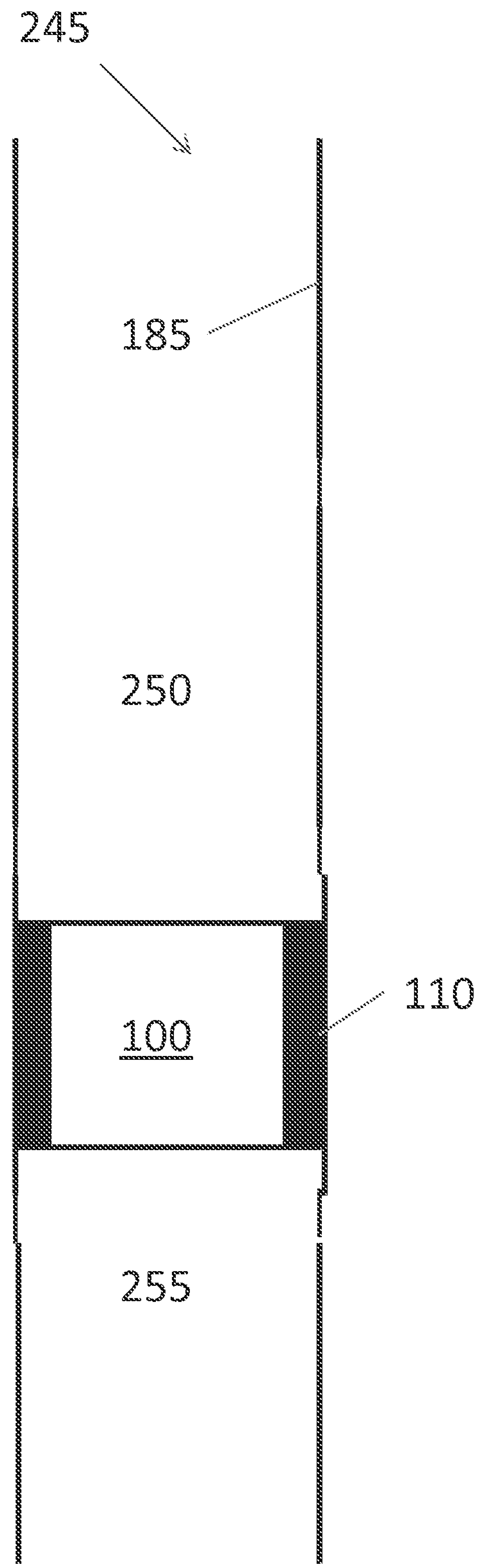

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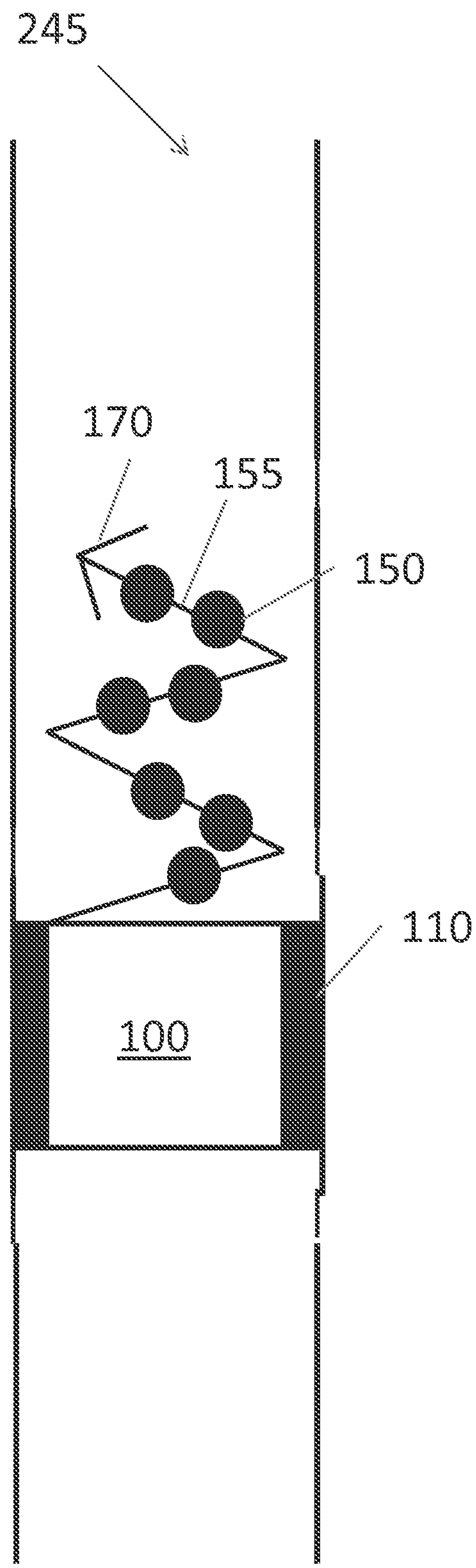

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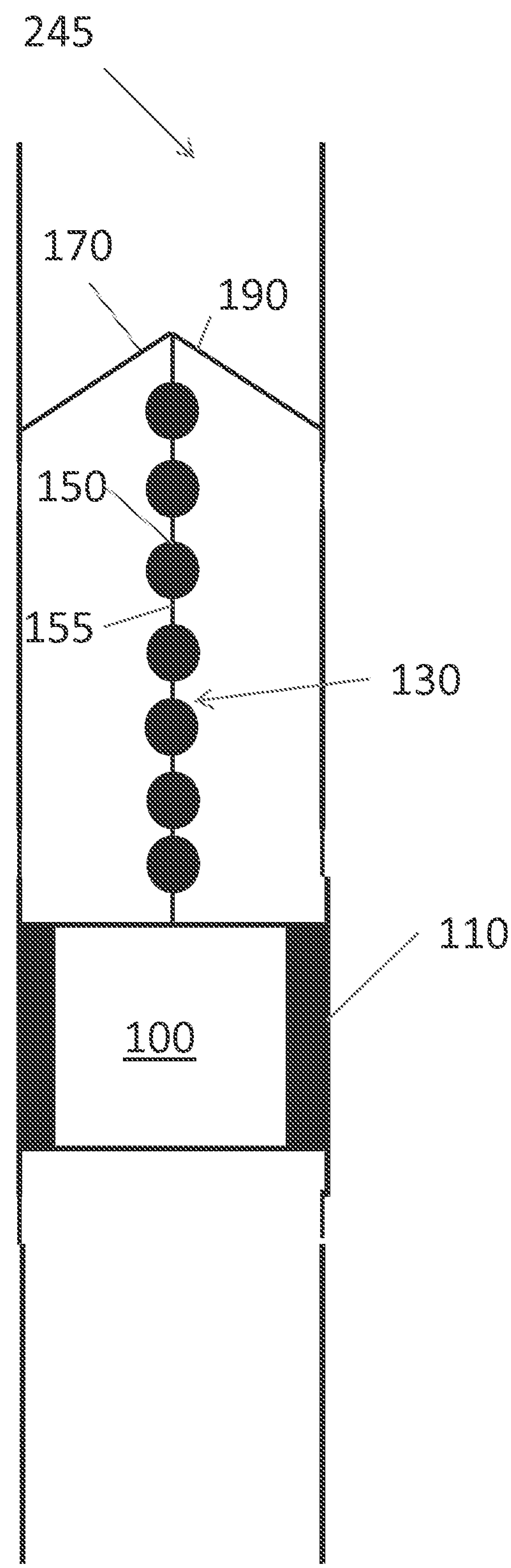

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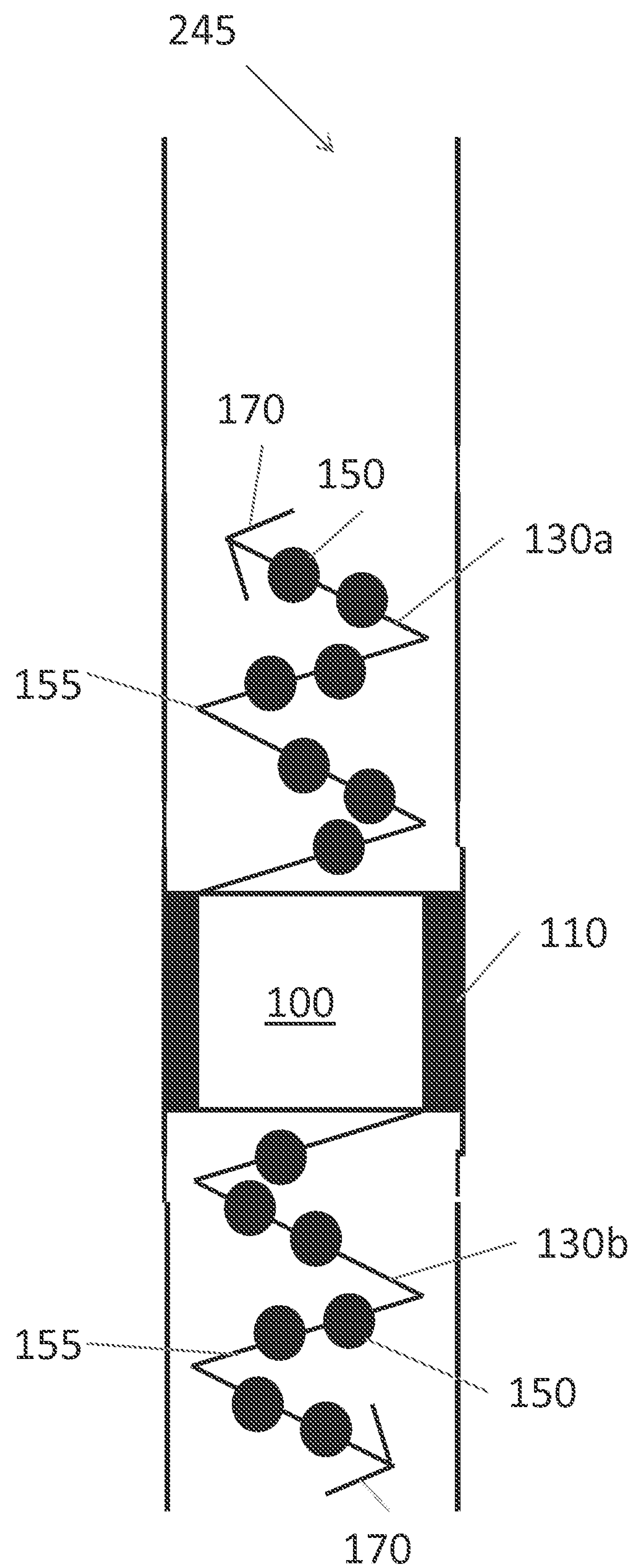

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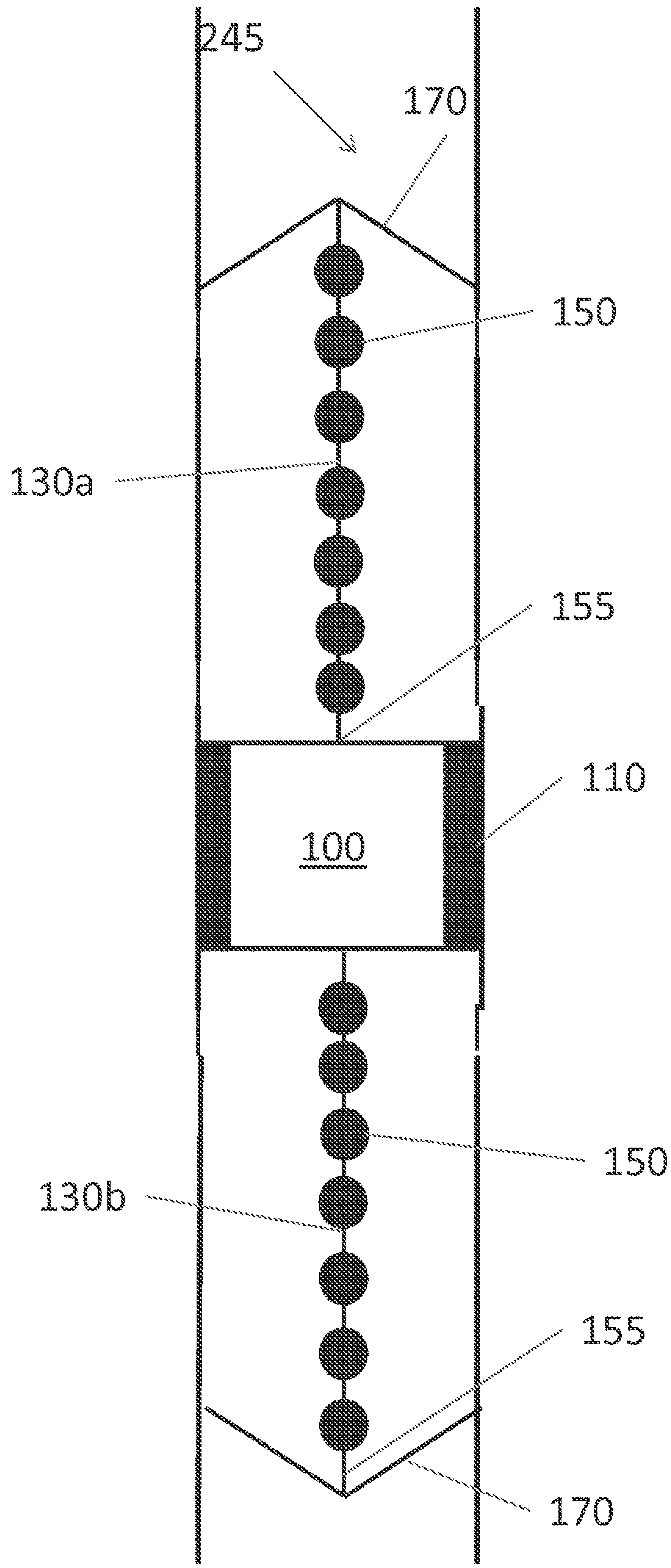

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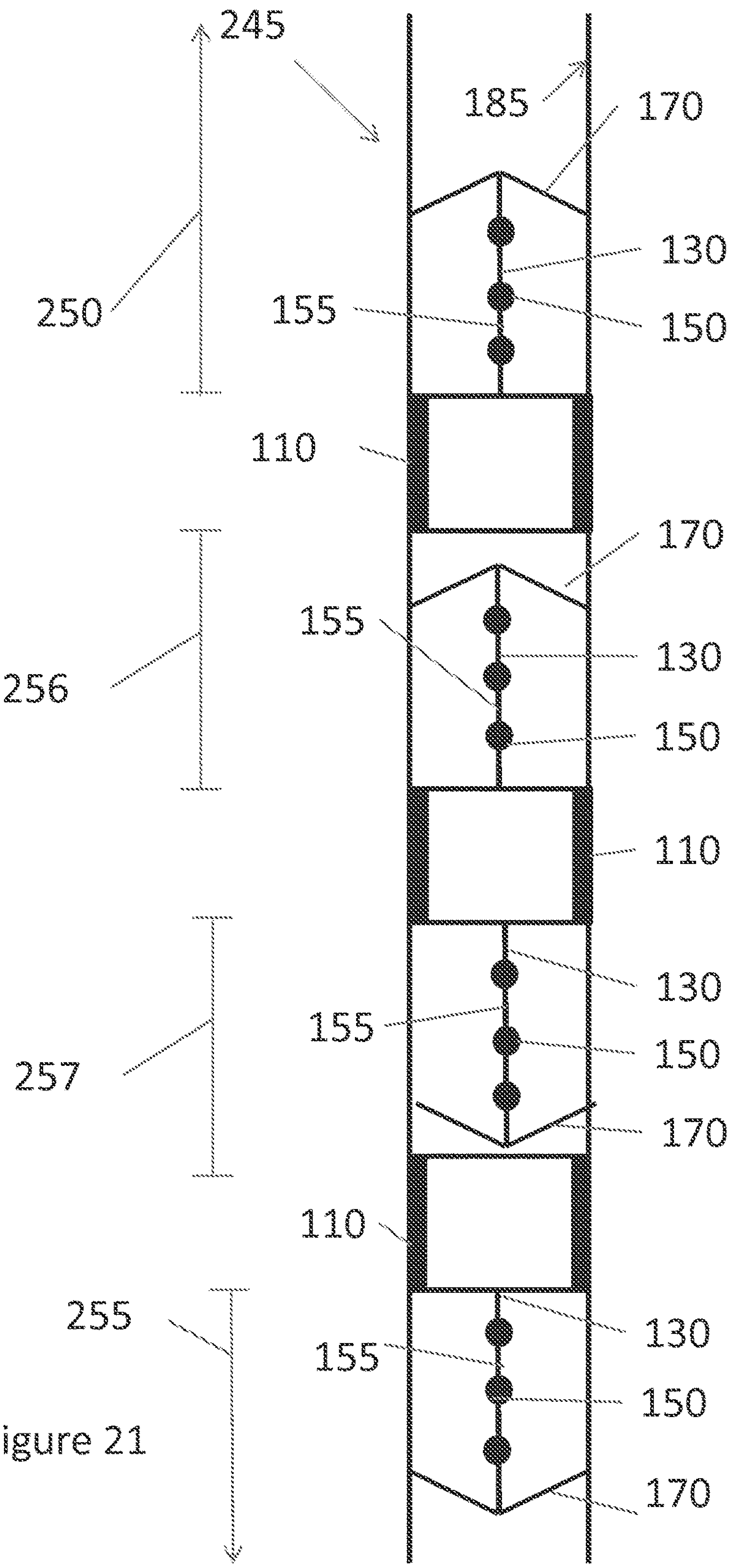
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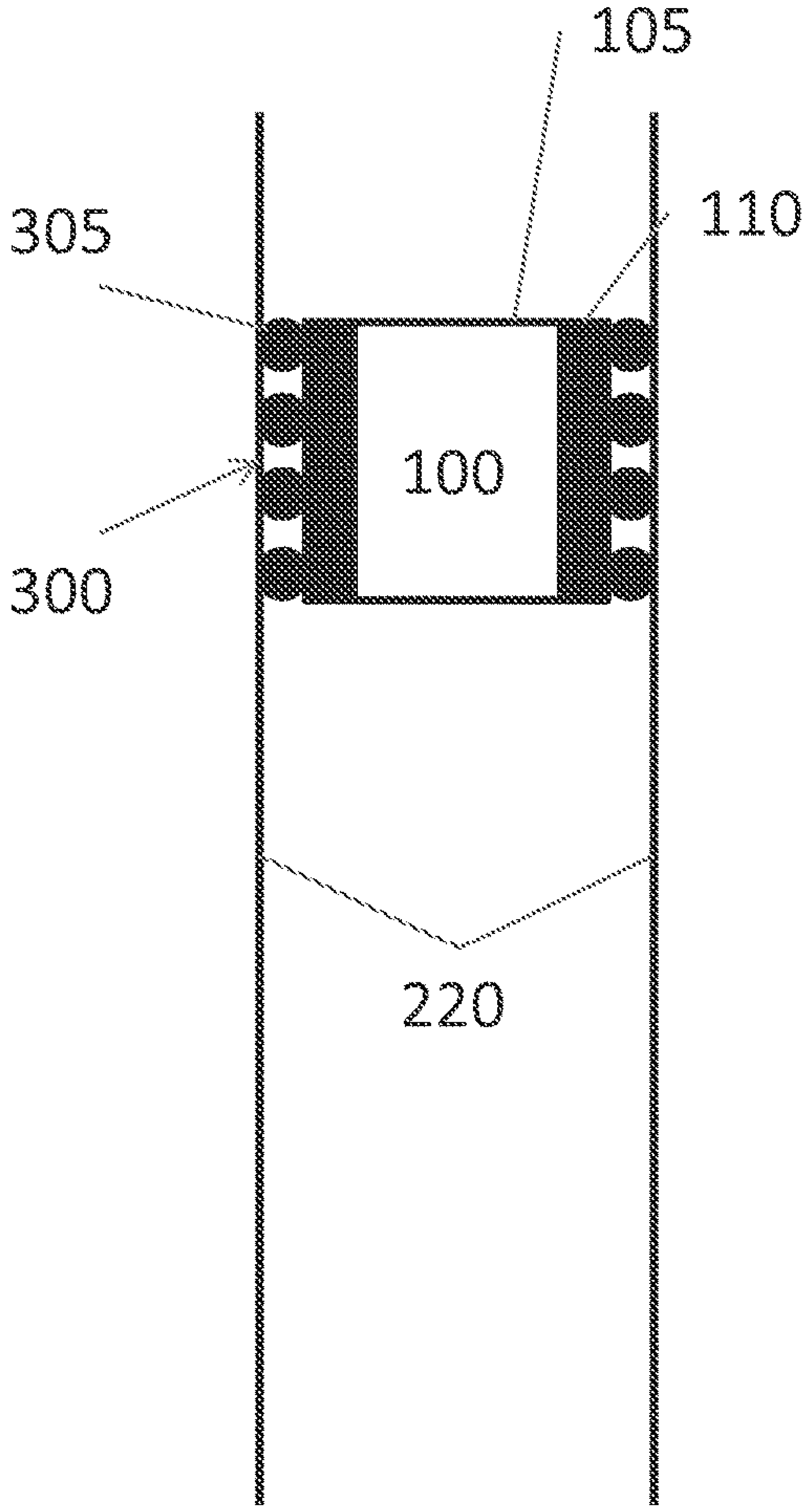
Figure 21



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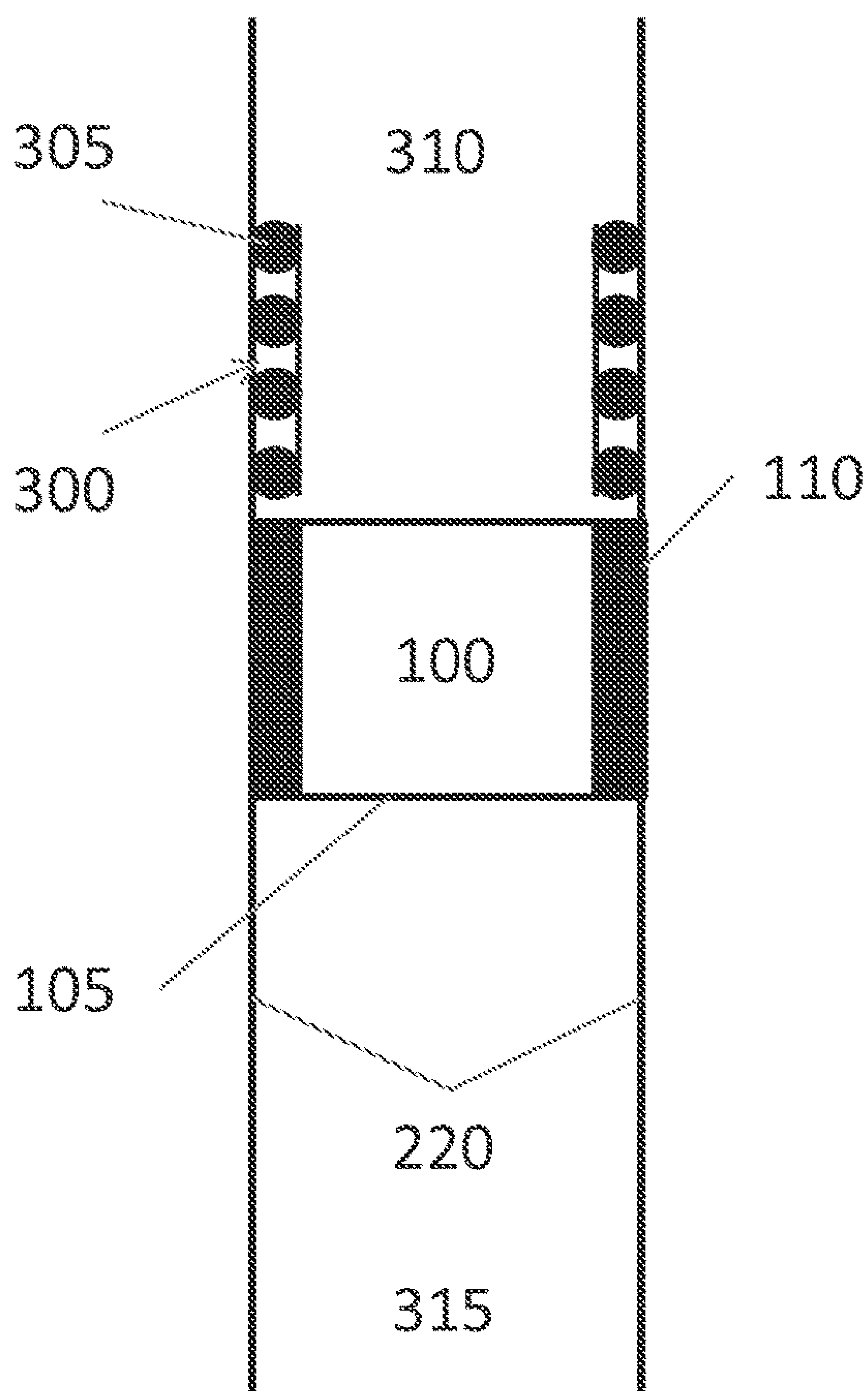

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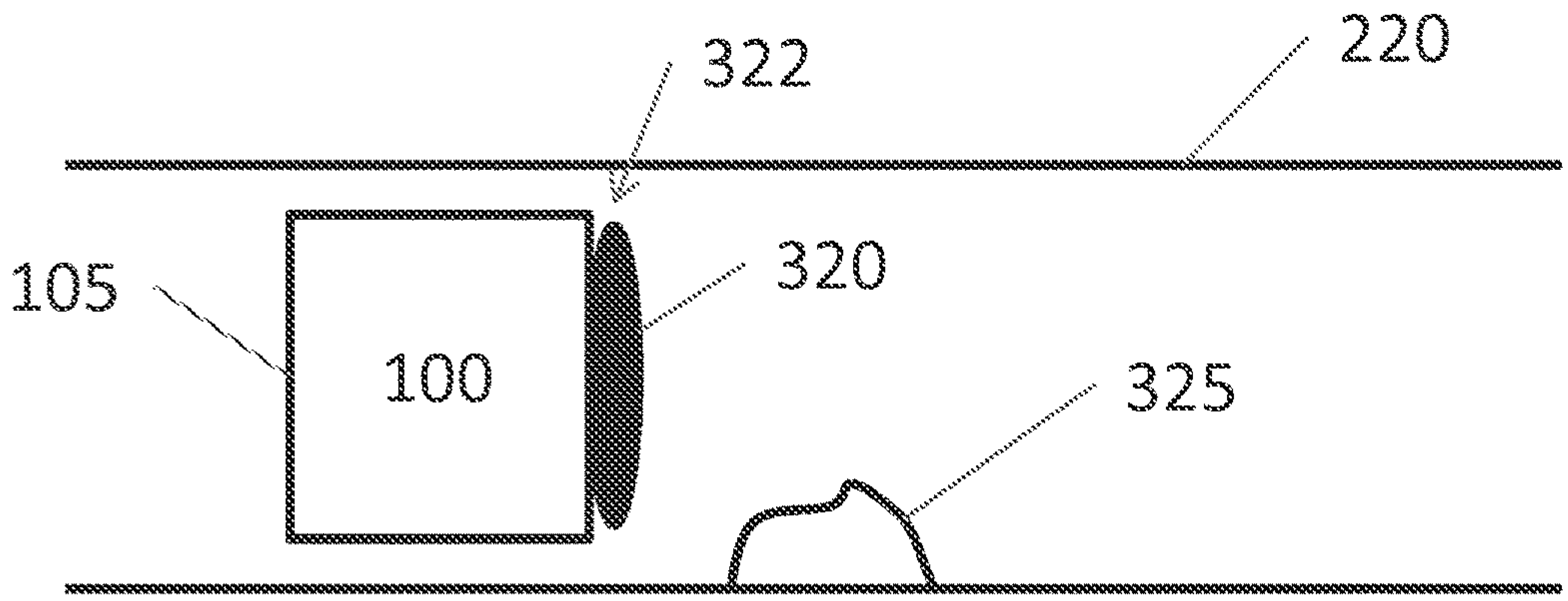

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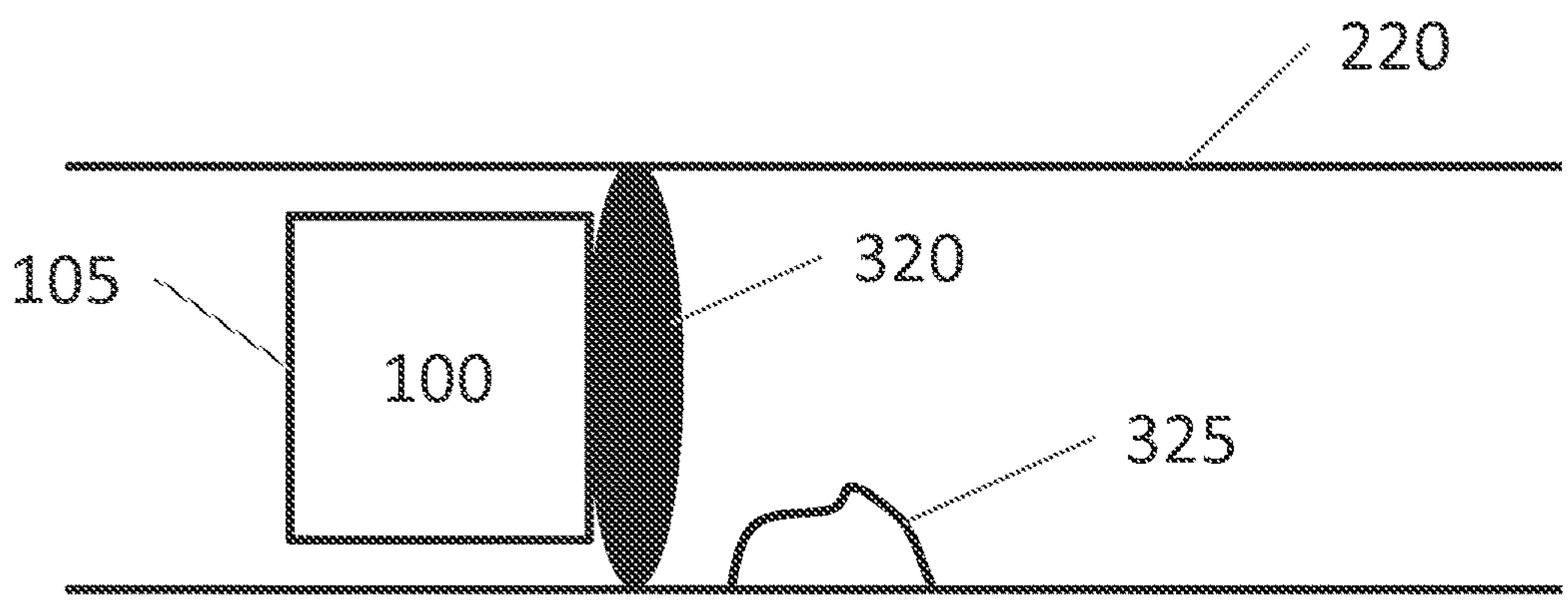

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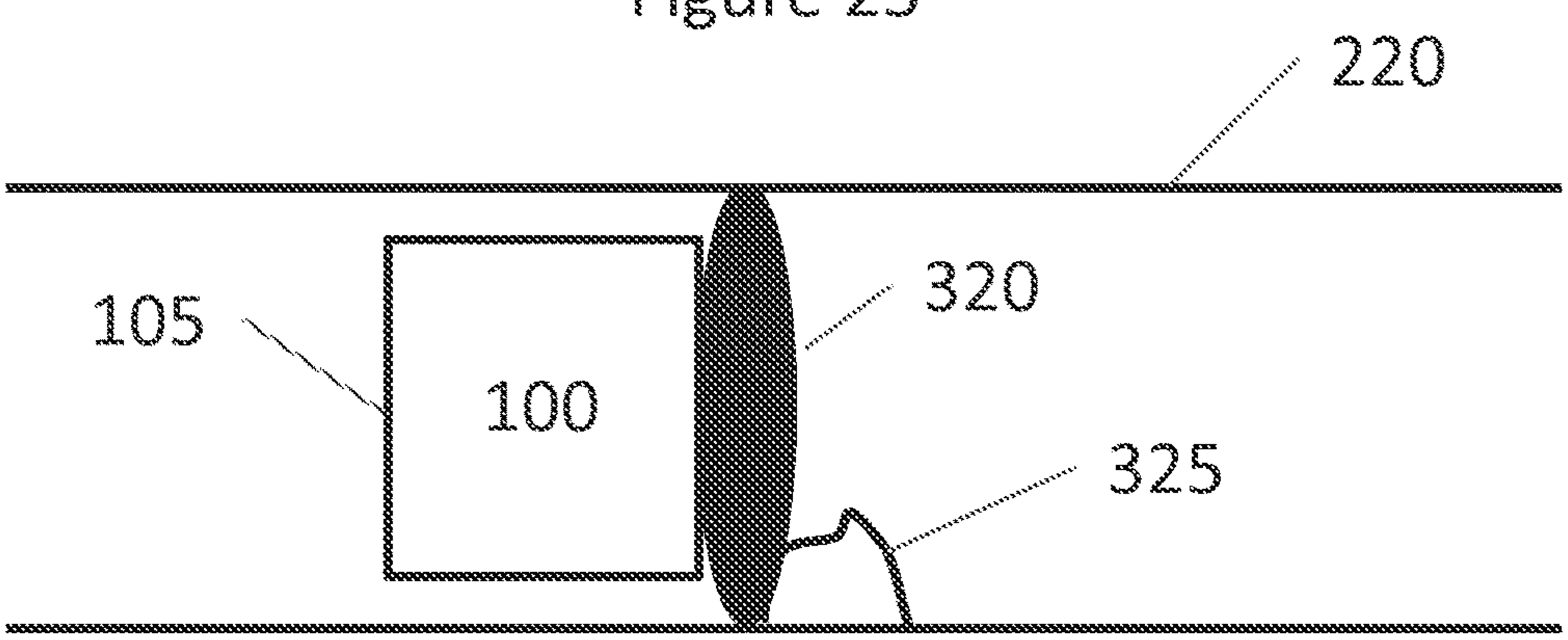

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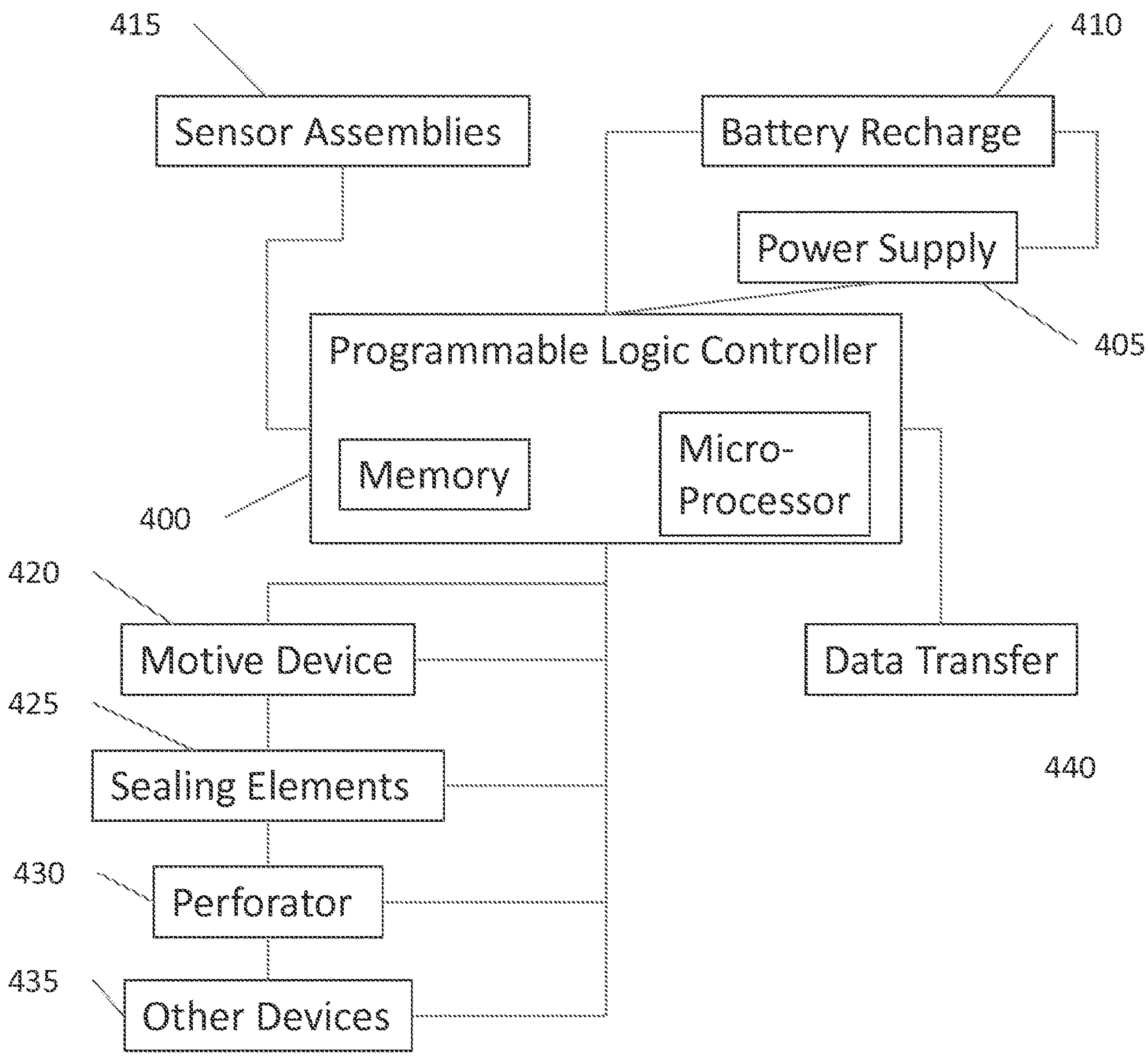
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Sensor Assemblies
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Battery Recharge
Power Supply
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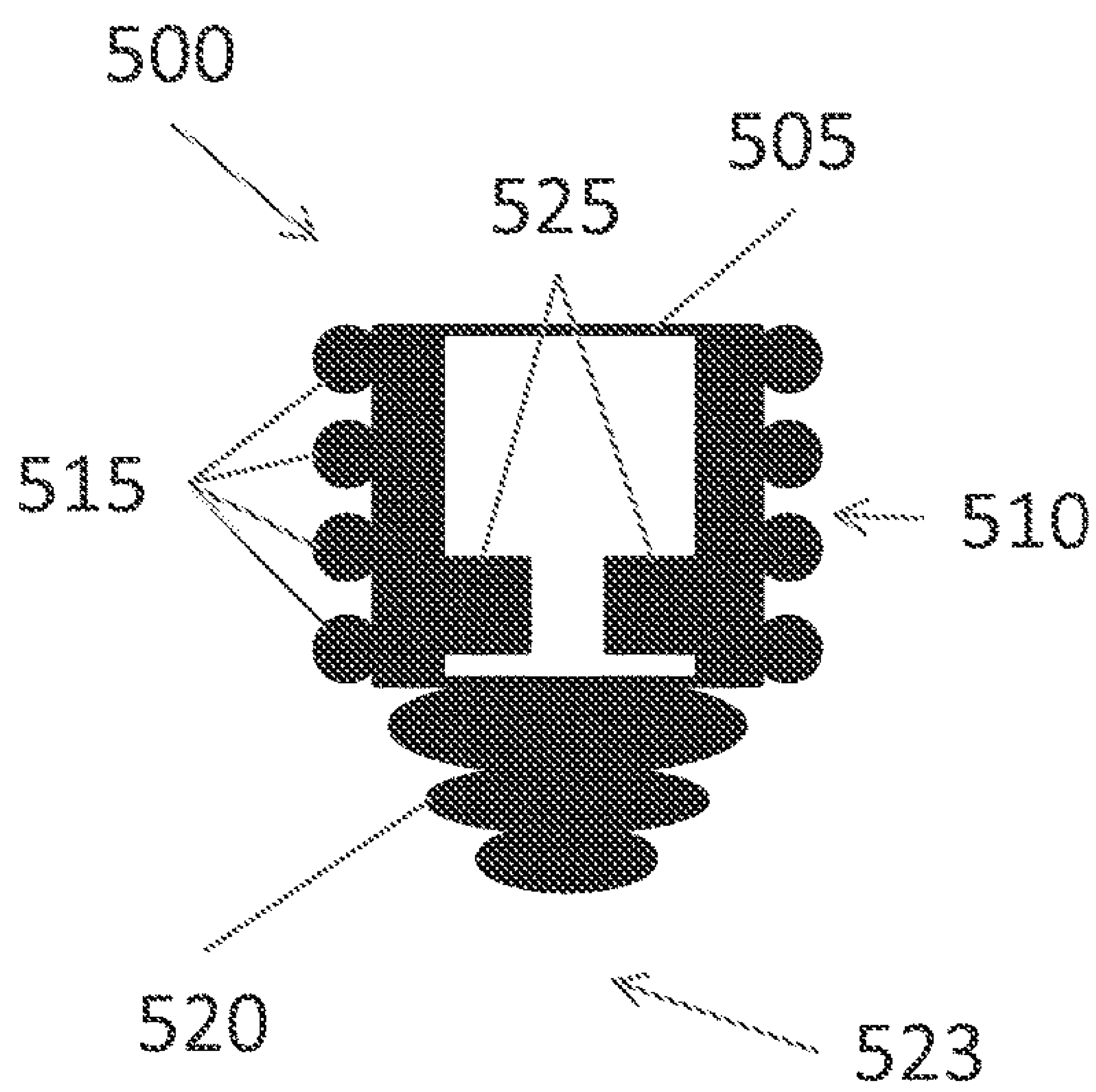
Programmable Logic Controller
Memory
Micro-
Processor
400
420
Motive Device
Data Transfer
425
Sealing Elements
440
430
Perforator
435
Other Devices

Figure 27



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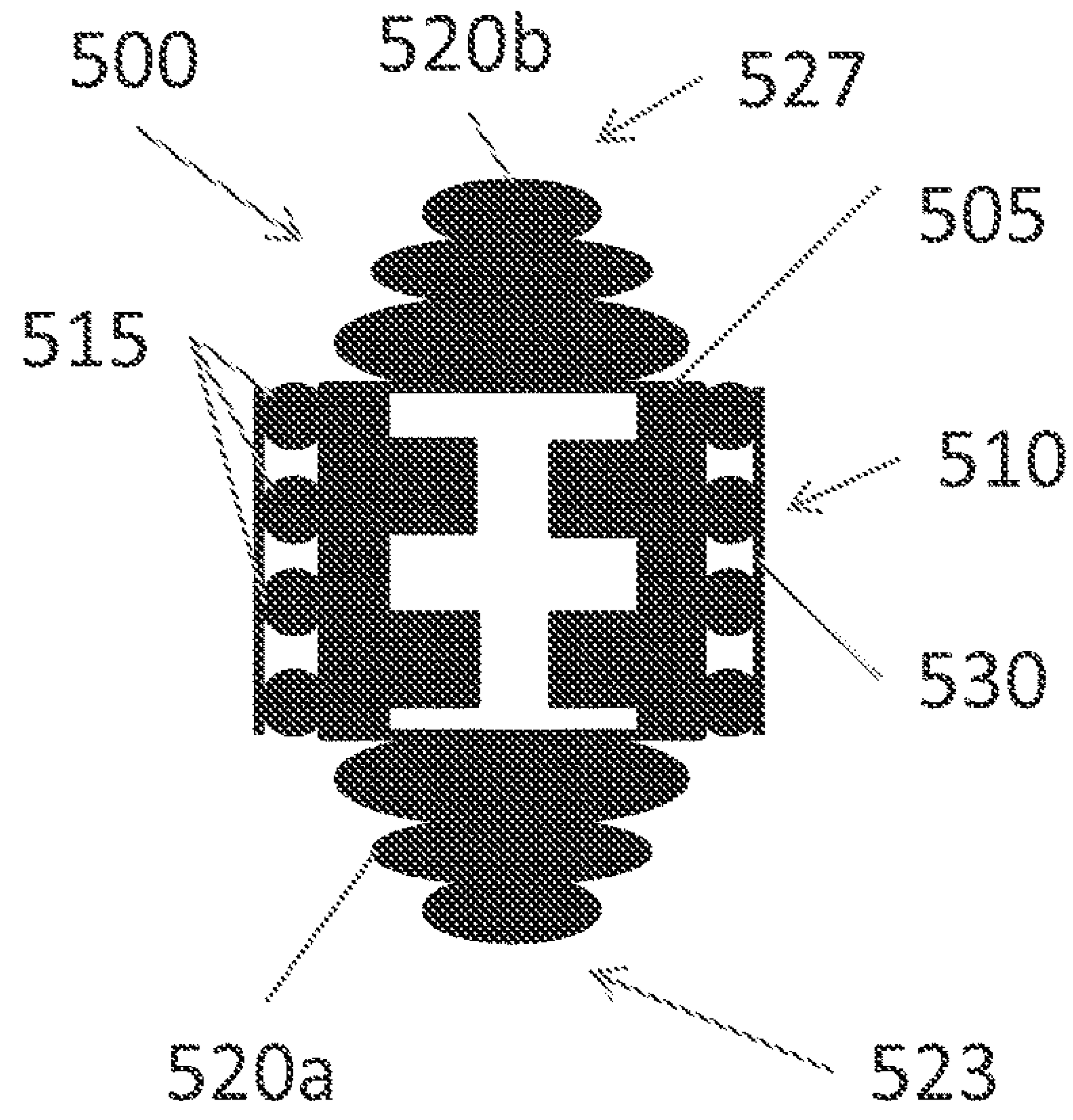

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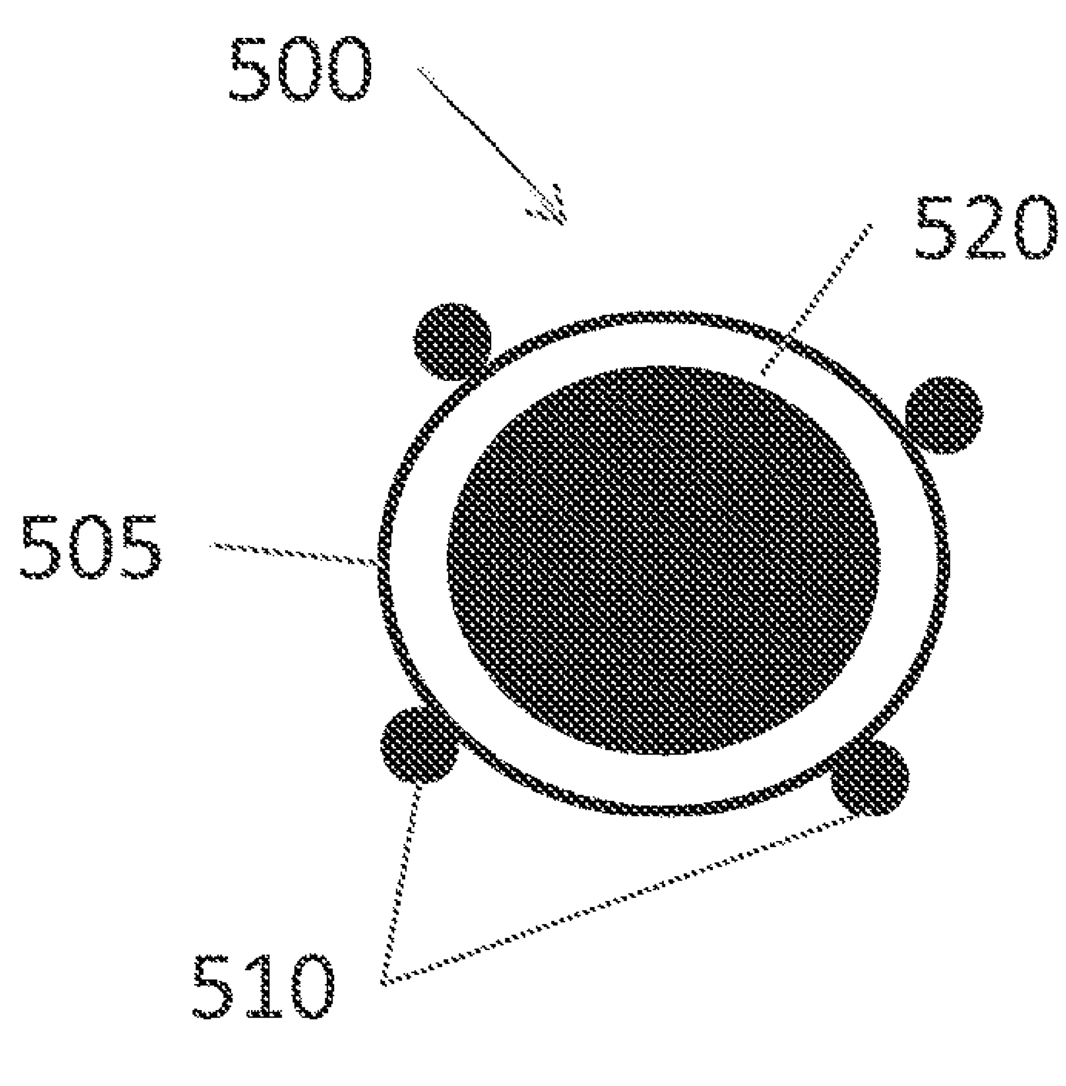

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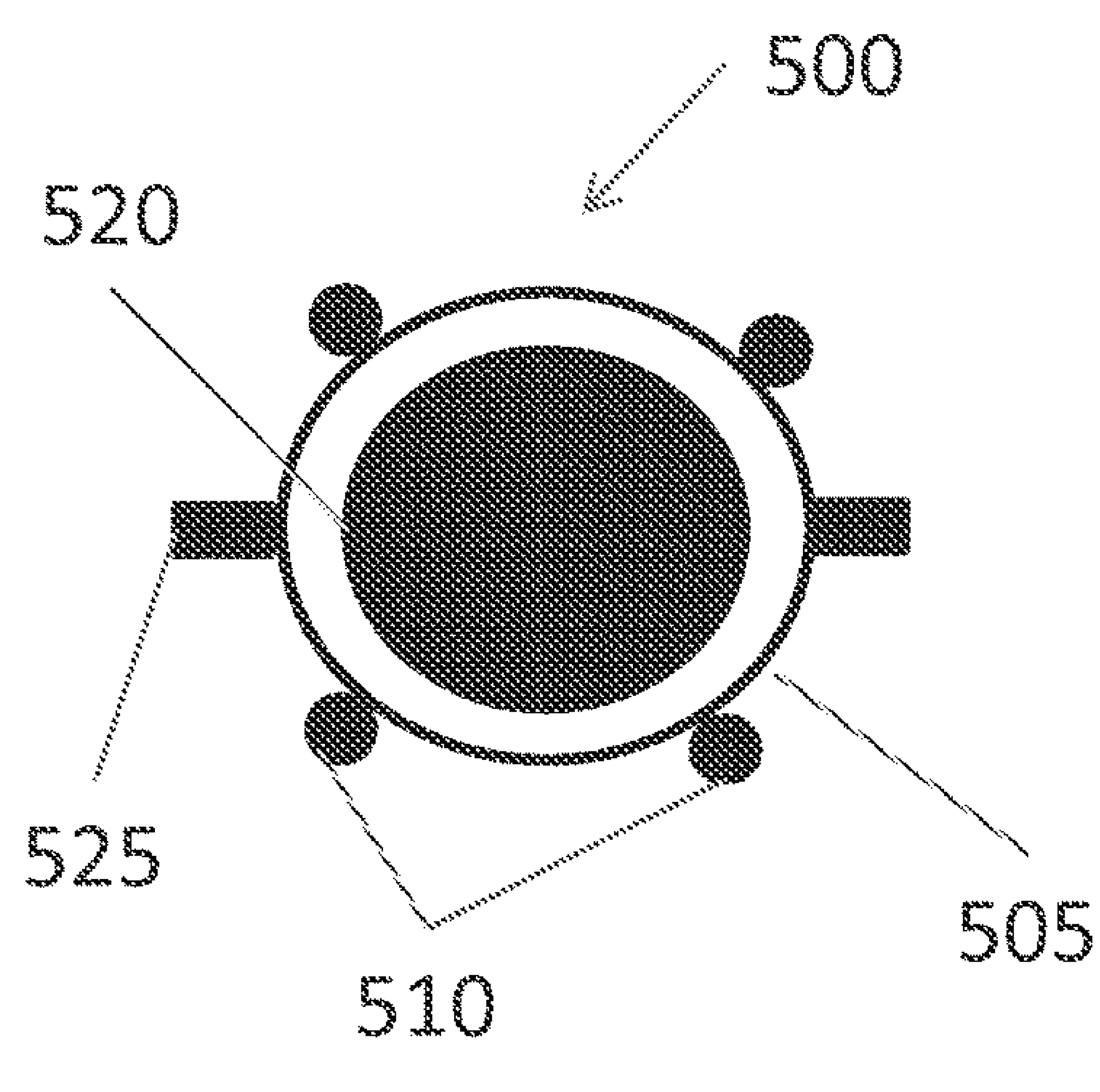

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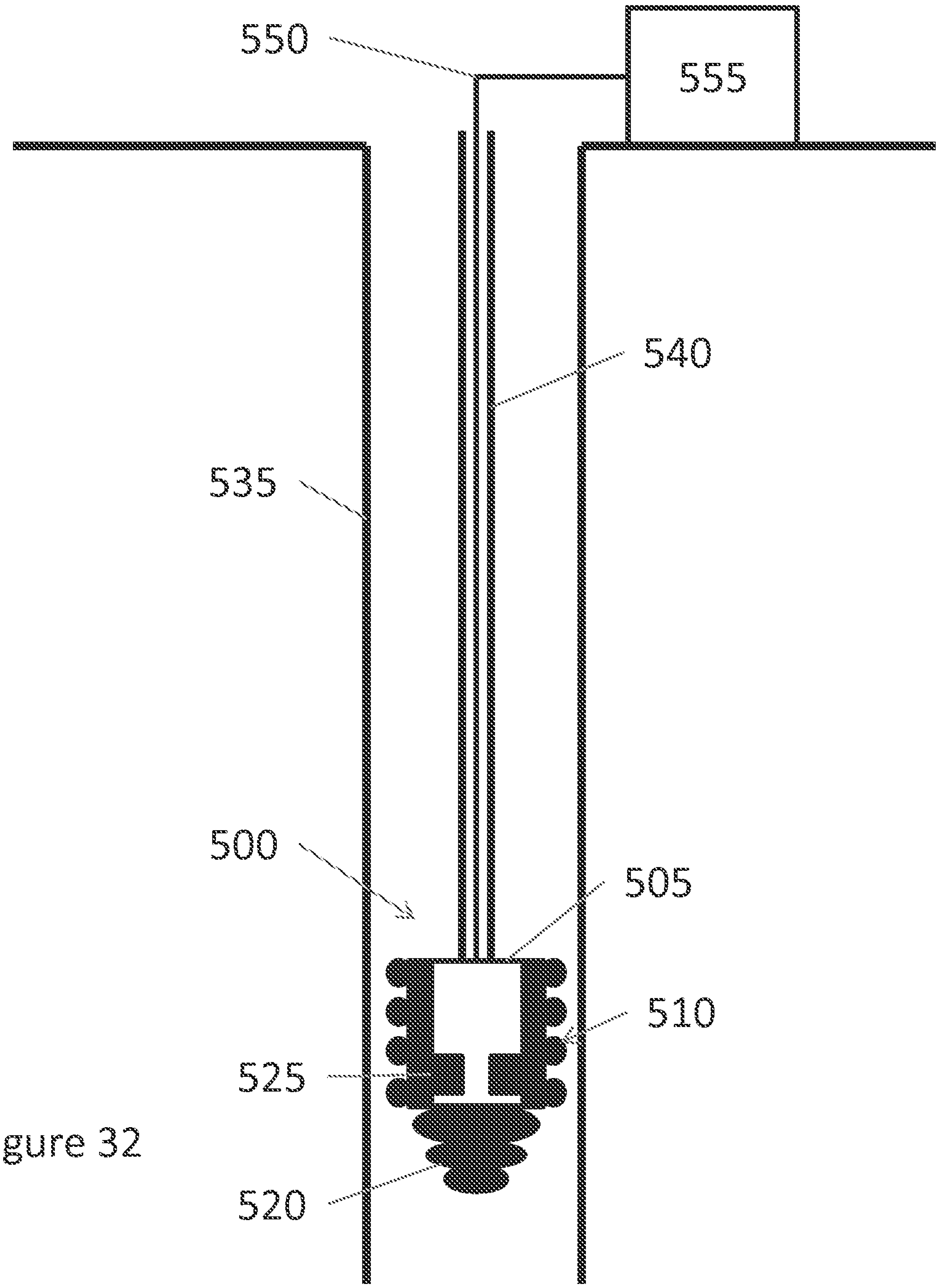

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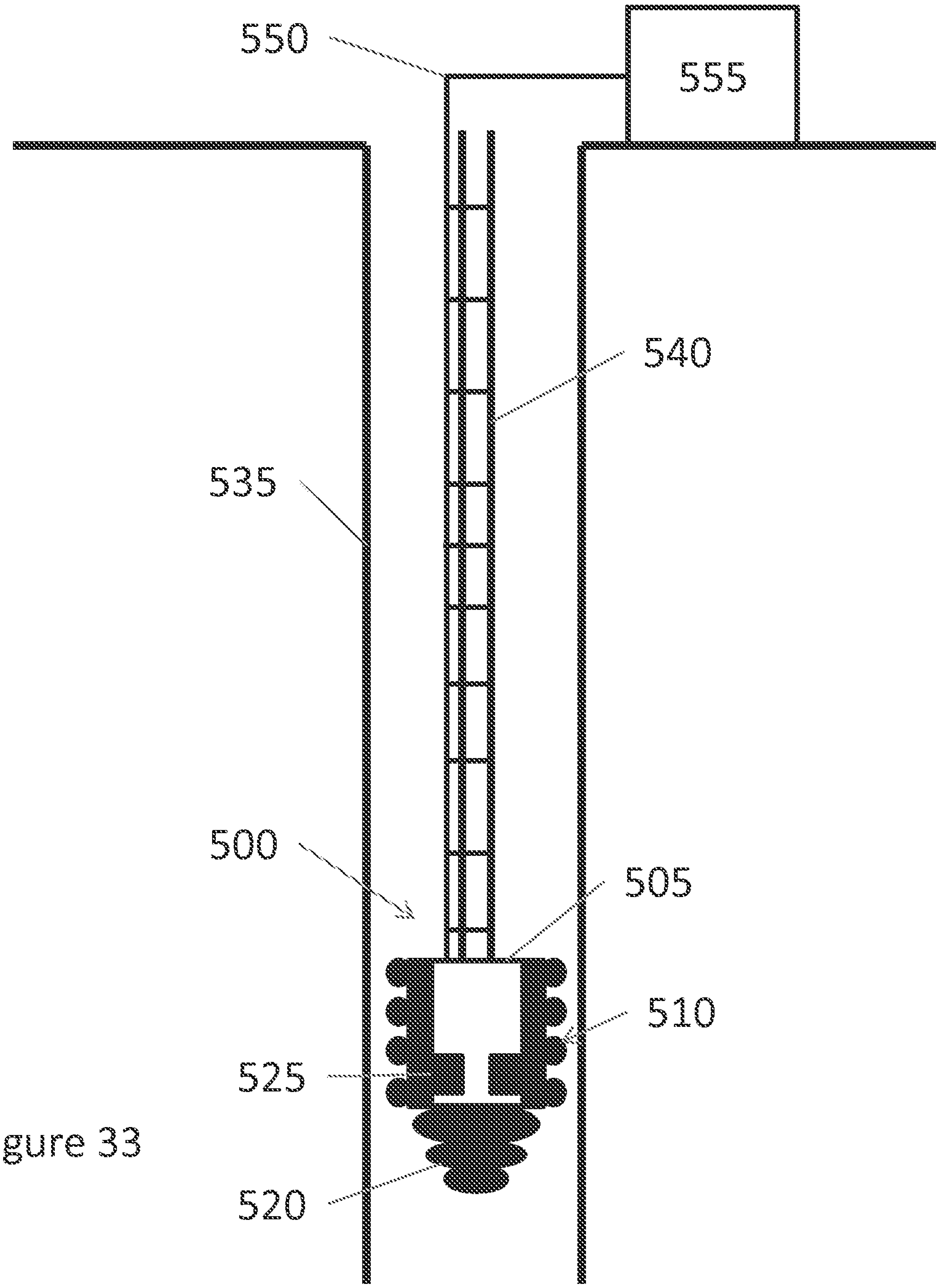

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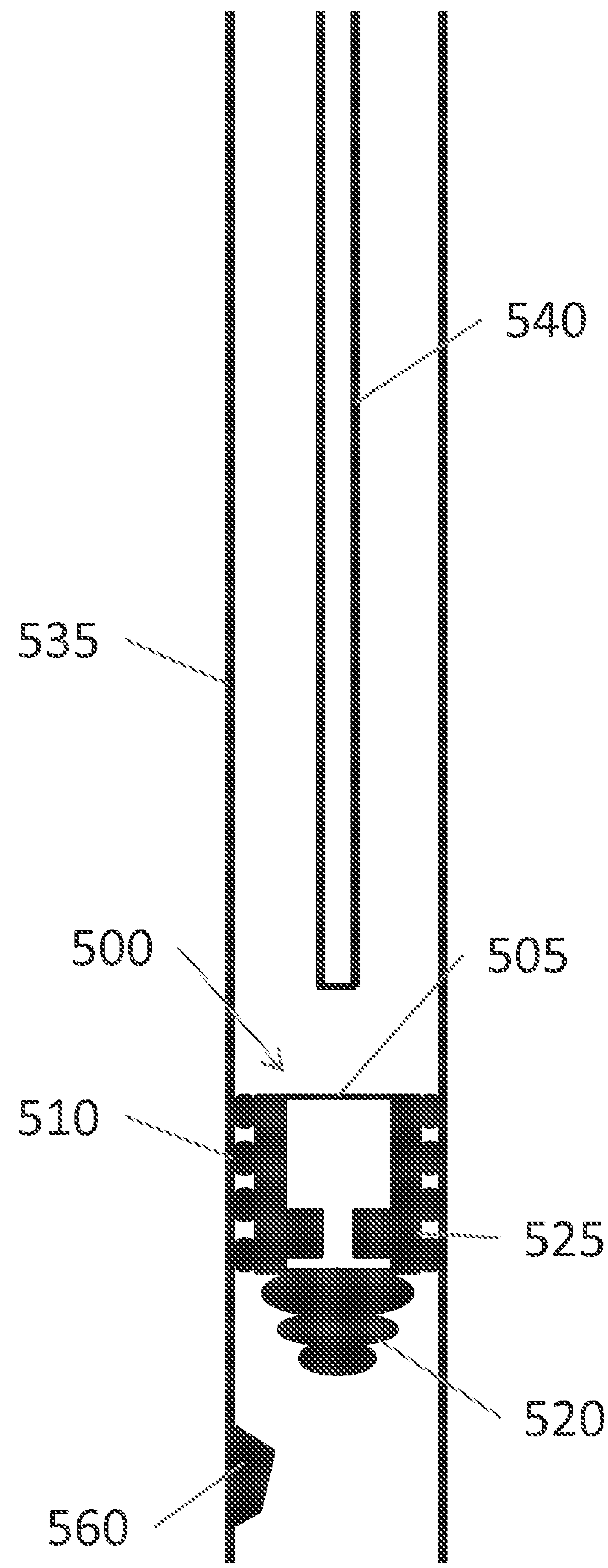

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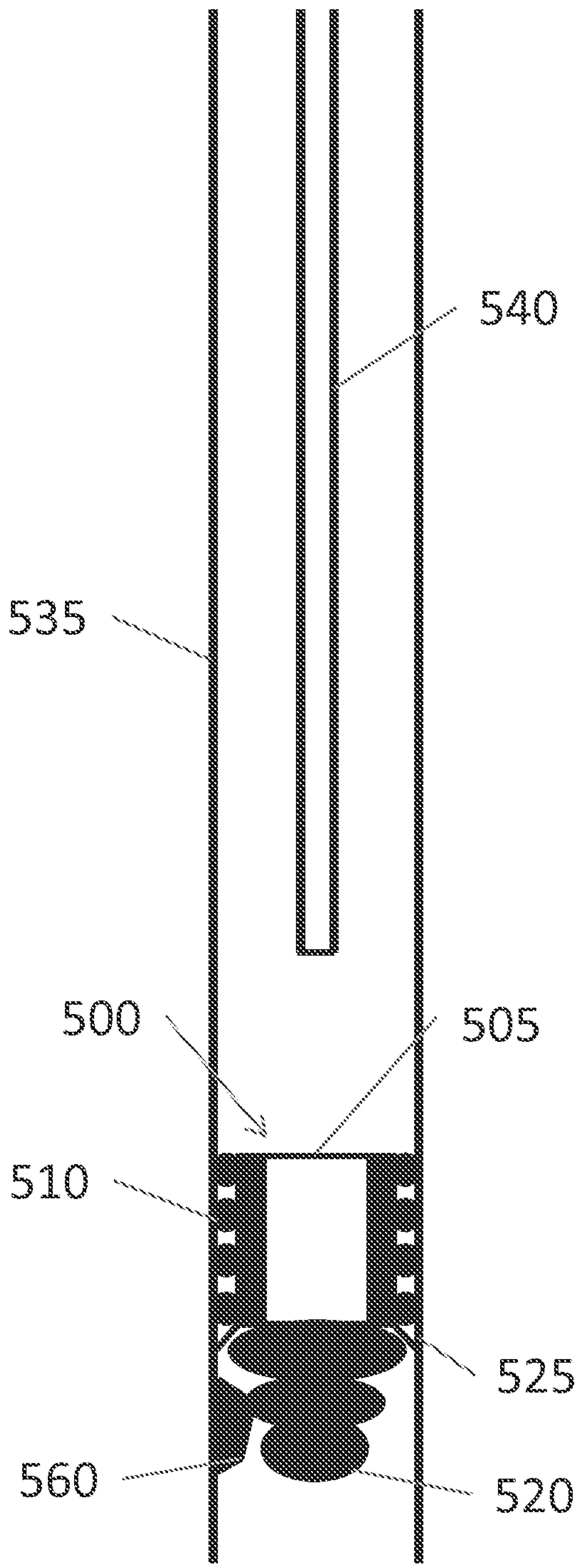

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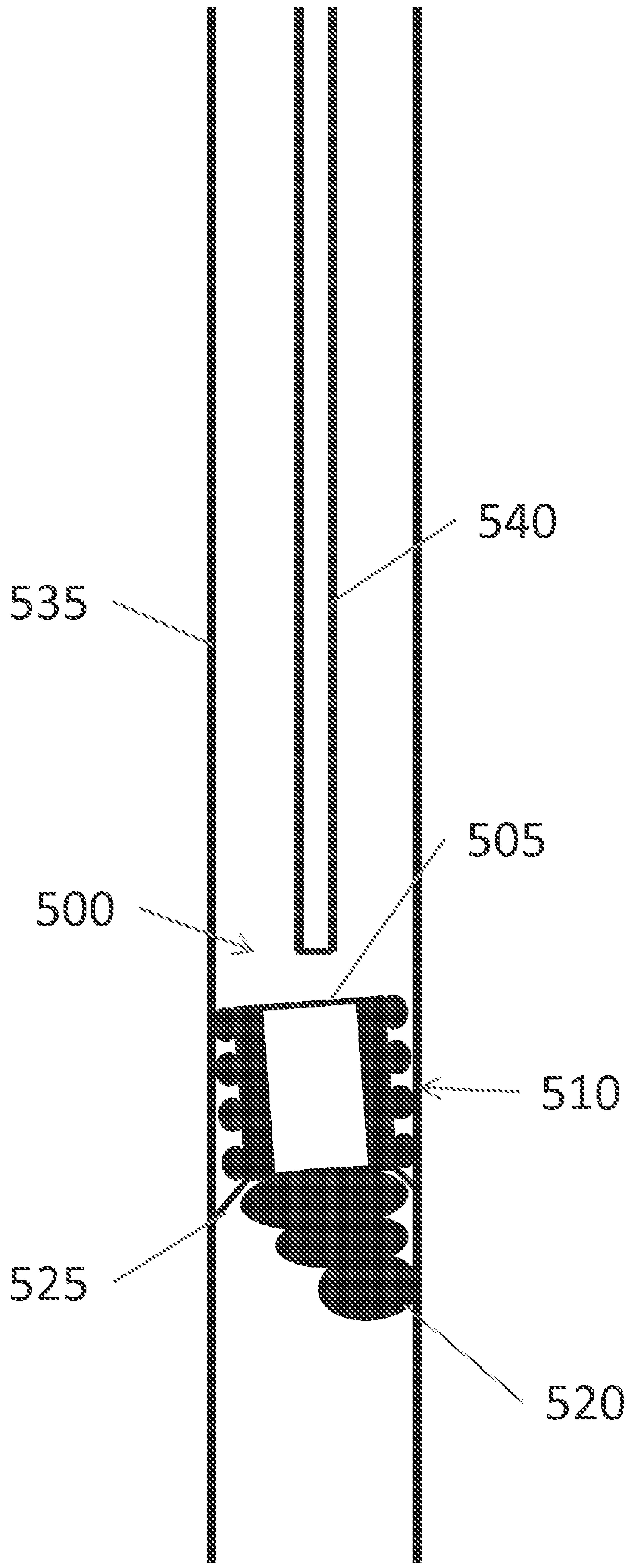

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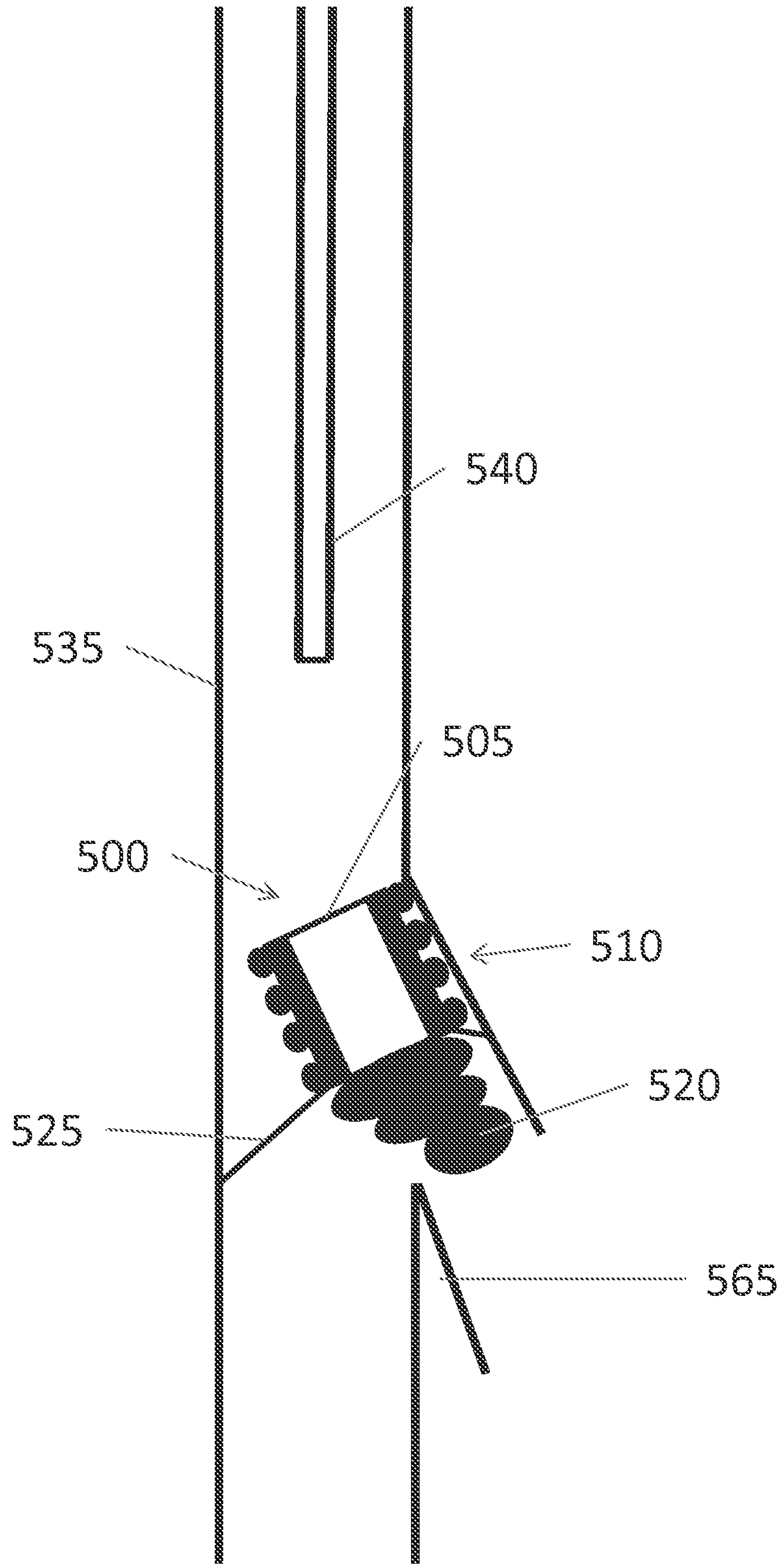

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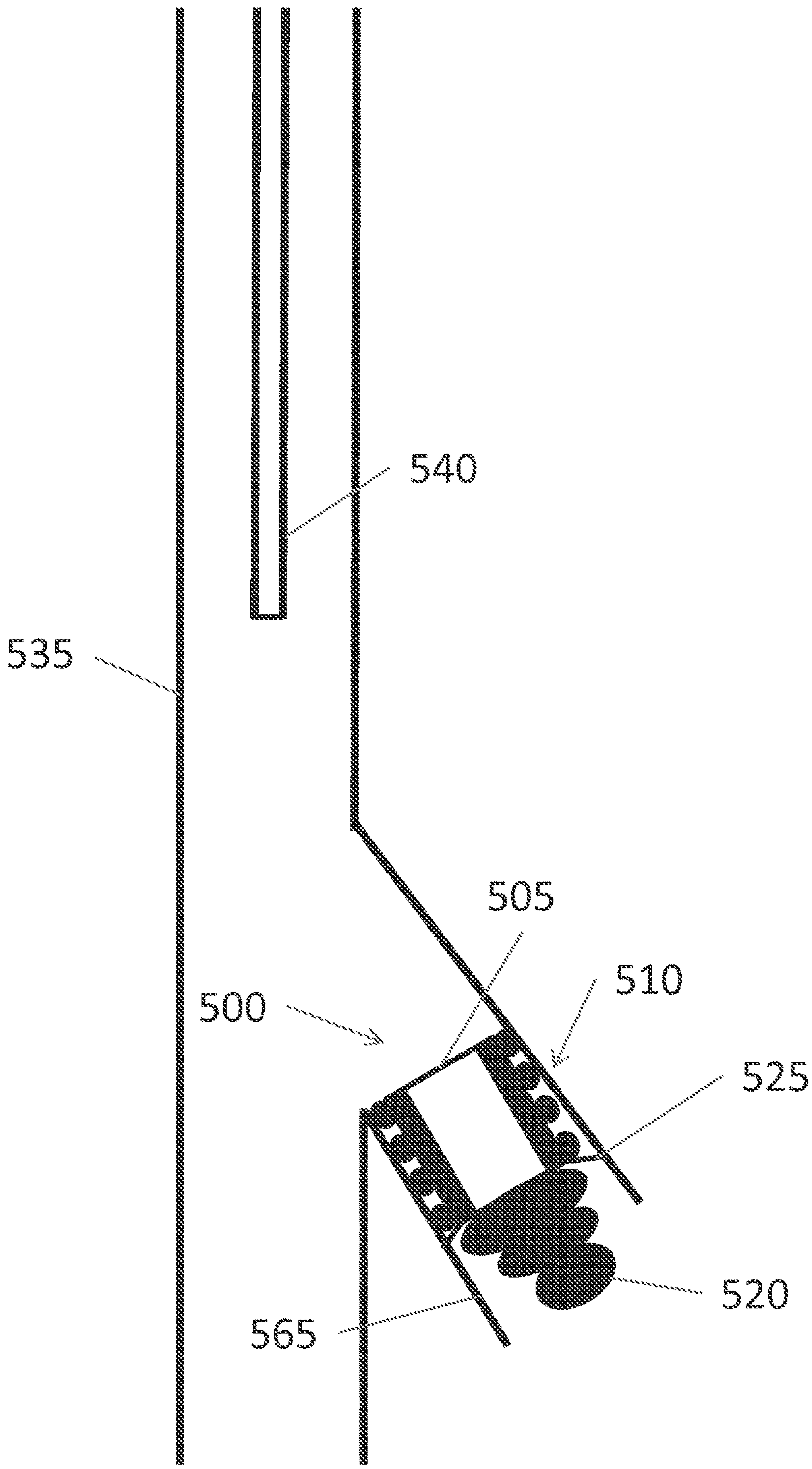

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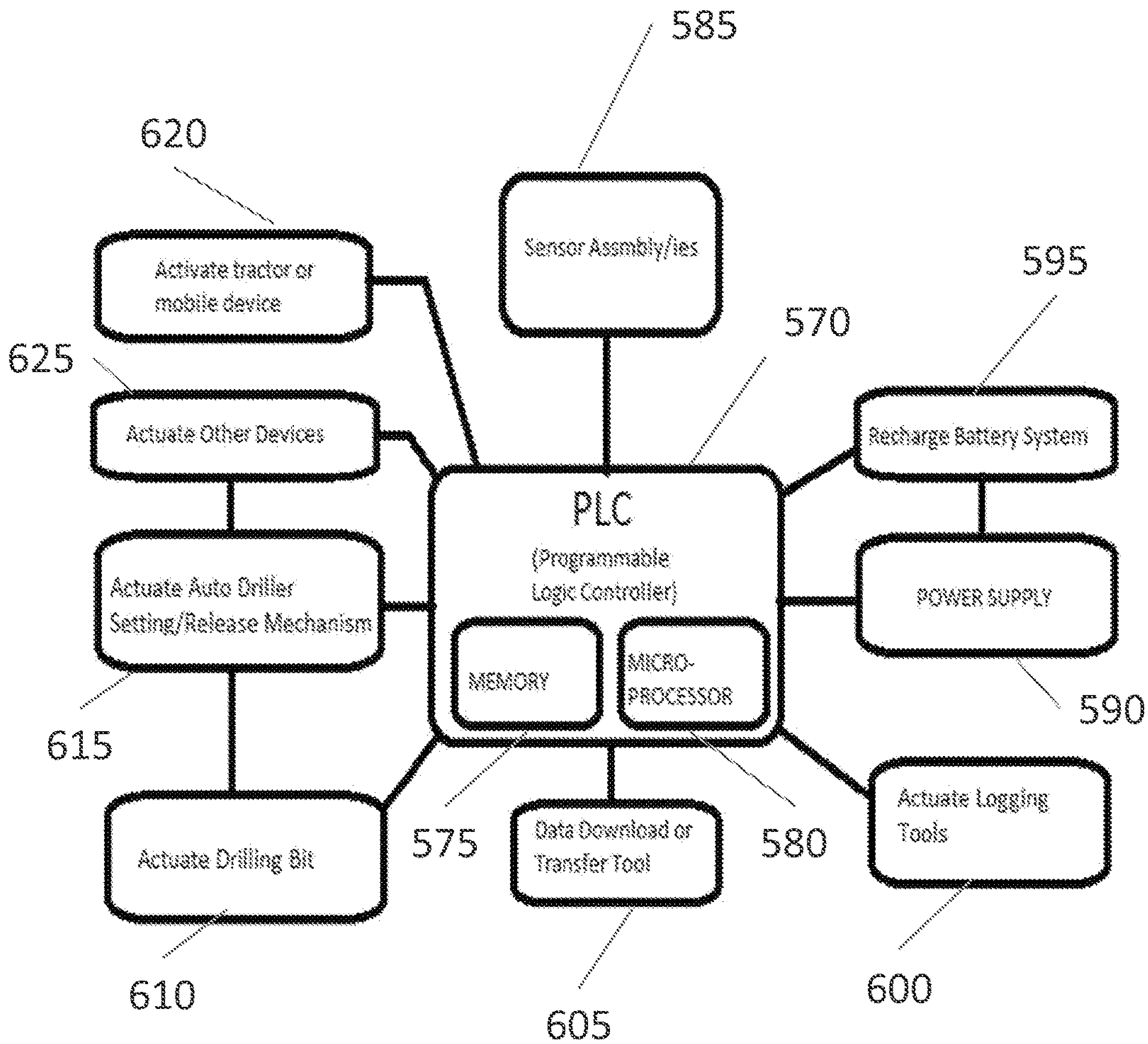
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Recharge Battery System
PLC
(Programmable Logic Controller)
Actuate Auto Driller Setting/Release Mechanism
POWER SUPPLY
MEMORY
MICRO-PROCESSOR
590
615
575
Data Download or Transfer Tool
580
Actuate Logging Tools
Actuate Drilling Bit
610
605
600

Figure 39

AUTOMATIC DRILLER

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit pursuant to 35 U.S.C. § 120, as a continuation-in-part application of U.S. application Ser. No. 13/959,912 filed Aug. 6, 2013. This application is incorporated by reference in its entirety.

BACKGROUND OF THE INVENTION

A producing well extracts oil and/or natural gas from one or more subsurface reservoirs of hydrocarbons. The development of a producing well includes drilling a borehole into the subsurface ground, casing the drilled borehole or leaving the borehole uncased, and completing the borehole to enable production.

After drilling a well for hydrocarbons, it may be necessary to perforate the walls of the well to facilitate flow of hydrocarbons into the well. Wells require perforation because the drilling process causes damage to the formation immediately adjacent to the well. This damage reduces or eliminates the pores through which the oil or gas would otherwise flow. Perforating the well creates a channel through the damage to undamaged portions of the formation. The hydrocarbons flow through the formation pores into the perforation channels and through the perforation channels into the well itself.

Traditional methods of perforating the well (both casing and the formation) involved lowering tools that contain explosive materials into the well adjacent to the hydrocarbon bearing formation. Discharge of the explosive would either propel a projectile through the casing and into the formation or, in the case of shaped charges, directly create a channel with explosive force. Such devices and methods are well known in the art.

In vertical wells, gravity may be used to lower the perforating device into position with wireline being used to hold the device against gravity and retrieve the device after discharge. For lateral wells, which may be horizontal or nearly horizontal, gravity may only be used to lower the perforating device with wireline to a point where the friction of the device against the well bore overcomes the gravitational force. The perforating device must then be either pushed or pulled along the lateral portion of the well until the device reaches the desired location.

Along with perforating the formation, packers may be used to isolate a section of the well for selective production and/or other downhole operations. A packer is a common downhole tool used in both the drilling and completion of a well. A packer typically has a sealing element, a holding or setting device, and a fluid passageway. Packers may be, but are not limited to, pneumatically or hydraulically expandable, swellable through use of a fluid, or expanded through fluid diffusion. Additionally, packers may seal through an elastomeric element that is solid and expands outwards under axial compression or tension. Production packers are used in completions to isolate an annulus between the casing or liner and the production tubing; and also between the open hole and a wellbore section. By creating a seal in the annulus, production control is achieved and tasks such as testing, fluid injection, perforation, treatment, and zonal isolation can be accomplished.

Expandable packers may be used for different sealing and partitioning purposes in boreholes. Typically, an annular packer is connected to a pipe, such as a production or

injection pipe, which is run into the borehole, after which, the annular packer is expanded against the formation wall or against a casing. Smaller packers may also be used within smaller tubulars within a wellbore to achieve desired sealing and partitioning.

BRIEF SUMMARY OF THE INVENTION

According to one aspect of one or more embodiments of the present invention, an automatic drilling apparatus having a tool body, a motive device connected to the tool body, and a drill bit connected to the tool body. The apparatus also includes a setting tool connected to the body, at least one sensor disposed on the tool body, and a computer disposed in the tool body, wherein the computer is configured to actuate the motive device, the drill bit, the setting tool, and the at least one sensor.

According to one aspect of one or more embodiments of the present invention, a method of clearing an obstruction from a well, the method including disposing an automatic driller in a well, wherein the automatic driller has a tool body, a drill bit, a setting tool, a motive device, at least one sensor, and a computer. The method further includes detecting an obstruction with the sensor, actuating the drill bit, and clearing the obstruction with the drill bit.

According to one aspect of one or more embodiments of the present invention, a method of drilling a secondary borehole, the method including disposing an automatic drilling in a well, wherein the automatic driller includes a tool body, a drill bit, a setting tool, a motive device, at least one sensor, and a computer. The method further includes moving the automatic driller to a secondary borehole location within the well, deploying the setting tool, actuating the drill bit, and drilling a secondary borehole with the drill bit.

Other aspects of the present invention will be apparent from the following description and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cross-sectional view of an automatic packer according to embodiments of the present disclosure.

FIG. **2** is a cross-sectional view of an automatic packer according to embodiments of the present disclosure.

FIG. **3** is a cross-sectional view of an automatic packer according to embodiments of the present disclosure.

FIG. **4** is a cross-sectional view of an automatic packer according to embodiments of the present disclosure.

FIG. **5** is a cross-sectional view of an automatic packer according to embodiments of the present disclosure.

FIG. **6** is a cross-sectional view of an extendable perforator according to embodiments of the present disclosure.

FIG. **7** is a cross-sectional view of an extendable perforator according to embodiments of the present disclosure.

FIG. **8** is a top cross-sectional view of an extendable perforator according to embodiments of the present disclosure.

FIG. **9** is a top cross-sectional view of an extendable perforator according to embodiments of the present disclosure.

FIG. **10** is a cross-sectional view of an automatic packer according to embodiments of the present disclosure.

FIG. **11** is a cross-sectional view of an automatic packer according to embodiments of the present disclosure.

FIG. **12** is a cross-sectional view of an automatic packer according to embodiments of the present disclosure.

FIG. **13** is a side view of an automatic packer according to embodiments of the present disclosure.

FIG. **14** is a cross-sectional view of a well according to embodiments of the present disclosure.

FIG. **15** is a cross-sectional view of an automatic packer in a well according to embodiments of the present disclosure.

FIG. **16** is a cross-sectional view of an automatic packer in a well according to embodiments of the present disclosure.

FIG. **17** is a cross-sectional view of an automatic packer in a well according to embodiments of the present disclosure.

FIG. **18** is a cross-sectional view of an automatic packer in a well according to embodiments of the present disclosure.

FIG. **19** is a cross-sectional view of an automatic packer in a well according to embodiments of the present disclosure.

FIG. **20** is a cross-sectional view of an automatic packer in a well according to embodiments of the present disclosure.

FIG. **21** is a cross-sectional view of multiple automatic packers in a well according to embodiments of the present disclosure.

FIG. **22** is cross-sectional view of an automatic packer in a well according to embodiments of the present disclosure.

FIG. **23** is a cross-sectional view of an automatic packer in a well according to embodiments of the present disclosure.

FIG. **24** is cross-sectional view of an automatic packer in a well according to embodiments of the present disclosure.

FIG. **25** is a cross-sectional view of an automatic packer in a well according to embodiments of the present disclosure.

FIG. **26** is a cross-sectional view of an automatic packer in a well according to embodiments of the present disclosure.

FIG. **27** is a schematic representation of the functionality of an automatic packer according to embodiments of the present disclosure.

FIG. **28** is a side cross-sectional view of an automatic driller according to embodiments of the present disclosure.

FIG. **29** is a side cross-sectional view of an automatic driller according to embodiments of the present disclosure.

FIG. **30** is a top view of an automatic driller according to embodiments of the present disclosure.

FIG. **31** is a top view of an automatic driller according to embodiments of the present disclosure.

FIG. **32** is a cross-sectional view of a well according to embodiments of the present disclosure.

FIG. **33** is a cross-sectional view of a well according to embodiments of the present disclosure.

FIG. **34** is a cross-sectional view of a well according to embodiments of the present disclosure.

FIG. **35** is a cross-sectional view of a well according to embodiments of the present disclosure.

FIG. **36** is a cross-sectional view of a well according to embodiments of the present disclosure.

FIG. **37** is a cross-sectional view of a well according to embodiments of the present disclosure.

FIG. **38** is a cross-sectional view of a well according to embodiments of the present disclosure.

FIG. **39** is a block diagram of a control system for an automatic driller according to embodiments of the present disclosure.

DETAILED DESCRIPTION OF THE INVENTION

One or more embodiments of the present invention are described in detail with reference to the accompanying figures. For consistency, like elements in the various figures are denoted by like reference numerals. In the following detailed description of the present invention, specific details are set forth in order to provide a thorough understanding of the present invention. In other instances, well-known features to one of ordinary skill in the art are not described to avoid obscuring the description of the present invention.

FIG. **1** shows a cross-sectional view of an automatic packer **100** in an unactuated condition according to embodiment of the present disclosure. In this embodiment, automatic packer includes a tool body **105**. The tool body **105** may be formed from various metals, metal alloys, and/or composites, such as polymers, carbon fiber, or Kevlar. For example, in one embodiment, tool body **105** may be formed from stainless steels, such as low alloy steels, e.g., 4140, Martensitic and PH stainless steels, e.g., 9Cr, 13Cr, 17-4PH, alloy 450, Super 13CR, and the like, nickel alloys, e.g., 825, 925, and 718, as well as nickel alloys, e.g., 625, 725, and C-276. In certain embodiments, portions or tool body **105** may be formed from cast iron, copper, bronze, and/or reinforced polymer-based composite. Tool body **105** may be of a generally cylindrical geometry such that tool body **105** may be disposed within a well or a wellbore.

Automatic packer **100** may further include at least one sealing element **110** disposed within tool body **105**. Sealing element **110** may be formed from various rubbers and/or elastomeric materials. Examples of materials that sealing element **110** may be formed from include Nitrile, bonded Nitrile, Viton, Molyglass, etc. Generally, any material that has high strength and high resiliency, while not being adversely affected by thermal and/or chemical environments may be used.

Sealing element **110** may be disposed circumferentially around tool body **105**, such that the sealing element **110** in a collapsed position, such as illustrated in FIG. **1**, does not extend outside of the outers diameter of tool body **105**. Thus, in certain embodiments, sealing element **110** may be disposed substantially within tool body **105** when automatic packer **100** is in a collapsed or unactuated condition. Automatic packer **100** may further include various other components, such as slips, slip assemblies, dogs, lockrings, seals, etc., that are not explicitly disclosed herein.

Automatic packer **100** may further include at least one sensor **115** disposed within tool body **105**. Sensor may be disposed such that a portion of sensor **115** extends from within tool body **105** through outer diameter of tool body **105**, thereby allowing sensor **115** to measure one or more conditions within the well. In some embodiments, sensor **115** may be disposed substantially within tool body **105** and not interact directly with the environment in the well. Sensor **115** may be configured to take measurements of one or more conditions within the well. For example, sensor **115** may be configured to measure a temperature, a pressure, a fluid type, a density, a specific gravity, an induction, a conduction, a refraction, infrared signal, a fiber optic signal, a load, an acceleration, a velocity, an ultrasonic signal, a tachometer measurement, a wireless transmission, a gyroscopic measurement, a casing collar locator, a modular reservoir dynamic test, and/or a position within the well. While automatic packer **100** is illustrated having two sensors **115**, those of ordinary skill in the art will appreciate that a single sensor **115** may be used, as well as more than two sensors. For example, in a certain embodiment, automatic packer **100** may have a different sensor for each parameter that is being measure. In other embodiments, automatic packer **100** may include a single sensor that takes multiple measurements, or several sensors that take single or multiple parameter measurements. A casing collar locator is an electric logging tool that detects a magnetic anomaly caused by the relatively high mass of the casing collar. A signal may be sent from the casing collar locator to surface equipment that provides a display and printed log to a surface operator. The information provided to the surface operator allows the information to be correlated with previous logs and known casing features, such as pup joints, thereby allowing the surface operator to determine the location of the tool within the well.

Sensors **115** may be connected to a data controller **120**. Data controller **120** may include a processor (not independently shown), memory (not independently shown), memory storage (not independently shown), and other components for processing and storing data measured by the at least one sensor **115**. Examples of a data controller may include, for example, a programmable logic controller ("PLC"). As illustrated, sensors **115** may be connected to data controller **120** through wiring **125**. In other embodiments, sensors **115** may be connected wirelessly to data controller **120**. Sensors **115** may also be connected directly to sealing element **110**, or a sealing element actuation mechanism (not independently shown) through additional wiring **125**. Depending on the design requirements for automatic packer **100**, sensors **115** may further be connected to various other components not expressly identified herein, thereby allowing automatic packer **100** to actuate based on parameters measured by sensors **115**. The actuation of automatic packer **100** will be described further below.

Sensors **115** may be configure to take substantially continuous measurements, or alternatively, may be configured to take measurements at selected intervals, such as selected time intervals. Additionally, as sensors **115** take measurements, the measurements may be sent to data controller **120**. Data controller **120** may include memory, as explained above, that is capable of storing the measurements. The stored data may be stored such that the data may be later downloaded at the surface for analysis or processing. Additionally, in certain embodiments, the measured data may be transmitted to the surface while automatic packer is downhole. In certain embodiments, the data transmission to the surface may occur through a wireline, e-line, wirelessly, through inductive pipe transmittance, plunger lift systems, etc. In some embodiments, a combination of both wired and wireless transmittance may be used to send signals to/from automatic packer **100** while downhole. For example, a wireline with a transferring/recording/receiving device may be lowered downhole. The wireline may be lowered through use of gravity, or in certain embodiments, through use of tractor devices, which are known in the art. When downhole, the transferring/recording/receiving device may initiate wireless communication with automatic packer **100**. Data may thus be transferred to/from automatic packer **100**, thereby allowing data to be sent to the surface and/or actuation signals to be sent from the surface to automatic packer **100**. In certain embodiments, automatic packer **100** may be reprogrammed through use of such a system.

In certain embodiments, sensors **115** may also include gyroscopes and relative closeness indicators. Relative closeness indicators, such as transmitters/receivers to measure the closeness of automatic packer **100** to a well bore wall may be used to determine a position of automatic packer **100** within the well.

Automatic packer **100** may further include a power source (not independently shown) connected to one or more of sensors **115** and/or data controller **120**. The type of power source used may vary according to the requirements of the operation, however, in certain embodiments one or more lithium ion batteries may be used to power sensors, data controller, or other devices disposed on automatic packer **100**. In certain embodiments, the power source may include a recharging battery system that is capable of being recharged either downhole, at the surface, or from the surface using wired connections.

In certain embodiments, automatic packer **100** may also include a wireless transmitter (not independently shown). The wireless transmitter may, in certain embodiments, be included as a component on data controller **120**, or may be a standalone device within tool body **105**. The wireless transmitter may be used to send data measured by sensors **115** to the surface of the well. The wireless transmitter may also be used to communicate the position or status of automatic packer **100** to the surface of the well. In certain embodiments, the wireless transmitter may be used to inform an operator of a wellbore whether automatic packer **100** has been actuated, and if so, the location of automatic packer **100** within the well.

In still other embodiments, automatic packer **100** may include a tractor or mobile deployment system capable of moving the automatic packer **100** into a desired position within the well. Those of ordinary skill in the art will appreciate that tractors and other mobile deployment systems are known in the art and may be used to pull or push automatic packer to a desired location within a well prior to actuation of automatic packer **100**. Such systems may be of particular use in highly deviated wells, or wells in which gravity alone may not carry automatic packer **100** to the desired deployment location.

Referring to FIG. **2**, a cross-sectional view of an automatic packer **100** in an actuated condition according to embodiments of the present disclosure is shown. As explained above with respect to FIG. **1**, automatic packer **100** includes a tool body **105**, a sealing element **110**, at least one sensor **115**, a data controller **120**, and wiring **125** connecting the at least one sensor **115** to the data controller **120** and the sealing element **110**.

In operation, automatic packer **100** is disposed within a well and falls within the well to a certain position. While automatic packer **100** falls within the well, sensors **115** measure and/or records conditions within the well. As described above, examples of conditions that sensors may measure include a temperature, a pressure, a fluid type, specific gravity spinner, induction, conduction, refraction, infrared, a load, an acceleration, a velocity, a fiber optic signal, an ultrasonic signal, a tachometer measurement, a wireless transmission, a gyroscopic measurement, a casing collar locator, a modular reservoir dynamic test, and/or a position within the well. When the automatic packer reaches a desired location within the well, automatic packer **100** may be actuated, thereby causing sealing element **110** to engage an inner diameter of the well. In certain embodiments, the inner diameter of the well may be a section of casing (not shown), while in other embodiments, such as an uncased well, the sealing element **110** may engage and inner diameter of a wellbore wall.

Various types of packers that are known in the art may be used with embodiments of the present disclosure. Examples of such packers may include composite, drillable, permanent and retrievable packers. The packers may be hydraulically set, differentially set, mechanically set, tension set, compression set, etc. Additionally, both small and large bore packers may be actuated using the methods described herein.

Additional methods for automatically actuating automatic packer **100** are discussed in detail below. Prior to discussing the actuation of automatic packer in detail, additional components that may be used according to embodiments of the present disclosure are discussed.

Referring to FIG. **3**, a cross-sectional view of an automatic packer **100** having an extendable perforator **130** according to embodiments of the present disclosure is shown. In this embodiment, automatic packer **100** includes a tool body **105**, a sealing element **110**, and sensors (not shown), and may also include various other devices, such as a data controller (not shown), a wireless transmitter (not shown), wiring (not shown), etc.

In FIG. **3**, automatic packer **100** is shown in an unexpanded or unactuated condition, such that sealing element **110** is not radially expanded. Automatic packer **100** also includes two perforator partitions **135**, a first perforator partition **135***a* disposed at a top portion **140** of automatic packer **100** and a second perforator partition **135***b* disposed at a bottom portion **145** of automatic packer **100**. First and second perforator partitions **135***a*/**135***b* may be used to store one or more extendable perforators **130**. As illustrated, automatic packer **100** includes a first extendable perforator **130***a* stored in first perforator partition **135***a* and a second extendable perforator **130***b* stored in second perforator partition **135***b*. The extendable perforators **130***a*/**130***b* each include a plurality of perforator charges **150**. Those of ordinary skill in the art will appreciate that the number of charges may vary based on the requirements of the operation. For example, extendable perforators **130***a*/**130***b* may include one charge, or may include tens of charges depending on the area being perforated.

Perforation charges **150** include an explosive device that uses a cavity-effect explosive reaction to generate a high-pressure, high-velocity jet that creates a perforation tunnel in formation. The shape of the explosives and container determine the shape of the jet and the performance characteristics of the perforation charge **150**. The perforation tunnel in the formation is caused by the high pressure and velocity of the jet, and causes materials, such as steel, cement, and rock to flow plastically around the jet path, thereby causing the tunnels to form.

Perforation charges **150** are disposed on wire **155** that is used to form extendable perforators **130***a*-**130***b*. The wire **155** may be any type of wiring that may be used to hold and actuate perforation charges **150**. For example, in certain embodiments, wire **155** may include a hollow section to allow additional wiring (not shown), to be run along extendable perforators **130***a*/**130***b*, thereby allowing a detonation signal to be sent from automatic packer **100**. In other embodiments, wire **155** may be able to carry a detonation signal directly from automatic packer **100** to perforation charges **150**.

Referring to FIG. **4**, a cross-sectional view of the automatic packer **100** of FIG. **3** in an actuated condition according to embodiments of the present disclosure is shown. In this embodiment, automatic packer **100** includes a tool body **105**, a sealing element **110**, and sensors (not shown), and may also include various other devices, such as a data controller (not shown), a wireless transmitter (not shown), wiring (not shown), etc. Automatic packer **100** also includes two extendable perforators **130***a*/**130***b* disposed on first and second perforator partitions **135***a*/**130***b*, respectively. extendable perforators **130***a*/**130***b* include a plurality of perforation charges **150** disposed on wire **155**.

As discussed briefly above, when automatic packer **100** is disposed in a well, automatic packer **100** travels down the well until it reaches a desired position. When the position is determined by the sensors (not shown), automatic packer **100** actuates, thereby causing sealing elements **110** to radially expand into contact with the inner diameter of the well (not shown). By radially expanding sealing elements **110**, the well (not shown) is divided into two portions, a top portion that extends above automatic packer **100** to the surface (not shown), and a bottom portion that extends below automatic packer **100** to the bottom of the well (not shown).

FIG. **4** illustrates two different methods for extending extendable perforators **130***a*/**130***b*. Top perforator partition **135***a* includes two hinged doors **160**, which upon actuation, open outwardly, thereby allowing extendable perforator **130***a* to extend axially upward within the well. Bottom perforator partition **135***b* includes a single hinged door **165**, which upon actuation, opens outwardly, thereby allowing extendable perforator **130***b* to extend axially downward within the well. As explained above, doors **160** and **165** may be hinged, thereby allowing doors **160** and **165** to remain attached to automatic packer **100**.

In other embodiments, actuation of automatic packer **100** may cause the doors **160** and **165** to blast outwardly from automatic packer **100**, thereby allowing extendable perforators **130***a*/**130***b* to be released from top and bottom perforator partitions **135***a*/**135***b*, respectively. In still other embodiments, any other type of device may be used to hold extendable perforators **130***a*/**130***b* with automatic packer **100**. For example, collapsible or radially retractable doors may be used, as well as telescoping doors. In still other embodiments, automatic packer **100** may not include doors, and rather include retention devices that hold extendable perforators **130***a*/**130***b* within top and bottom perforator partitions **135***a*/**135***b*, respectively. In such an embodiment, the top and bottom perforator partitions **135***a*/**135***b* would not be isolated from the well environment during actuation. In certain embodiments, top and bottom perforator partitions **135***a*/**135***b* may be isolated from one another through use of a valve (not shown) disposed between the two partitions. The valve may be controlled through use of a data controller or PLC (not shown) that may be manipulated in order to control top and bottom perforator partitions **135***a*-**135***b*.

In still other embodiments, the doors **160**/**165** may dislodge from the automatic packer **100** as part of the extendable perforators **130***a*/**130***b*. In such an embodiment, doors **160**/**165** may form a parachute that acts as a brake or drag device to hold extendable perforators **130***a*/**130***b* in tension. Dislodged doors **160**/**165** may also be used to slow down automatic packers **100** decent within the well in order to put automatic packer **100** into position prior to actuation. In other embodiments, extendable perforators **130***a*/**10***b* may be released through use of a pump out plug or rupture of a rupture disk, such as a disk made from glass or ceramic that is configured to rupture upon application of a specific pressure.

Referring to FIG. **5**, a cross-sectional view of automatic packer **100** of FIGS. **3** and **4** according to embodiments of the present disclosure is shown. In this embodiment, automatic packer **100** includes a tool body **105**, a sealing element **110**, and sensors (not shown), and may also include various other devices, such as a data controller (not shown), a wireless transmitter (not shown), wiring (not shown), etc. Automatic packer **100** also includes two extendable perforators **130***a*/**130***b* disposed on first and second perforator partitions **135***a*/**135***b*, respectively. Extendable perforators **130***a*/**130***b* include a plurality of perforation charges **150** disposed on wire **155**.

In FIG. **5**, extendable perforators **130***a*/**130***b* are shown expanding longitudinally upward and downward, respectively. As illustrated, the wire **155** expands upwardly and downwardly, thereby separating the charges longitudinally within the well (not shown). In order to ensure extendable perforators **130***a*/**130***b* expand longitudinally fully within the well (not shown), a well retention device **170***a*/**170***b* may be disposed at a terminal end **175** of extendable perforators **130***a*/**130***b*, respectively. Well retention device **170***a*/**170***b* may include a radially projection that is configured to engage the inner diameter of the well, whether the well is cased or uncased.

Depending on the type of well, well retention device **170***a*/**170***b* may include a plurality of externally projecting teeth (not independently illustrated), which may be formed from, for example, steel or tungsten carbide. Additionally, well retention device **170***a*/**170***b* may include hardfacing, such as tungsten carbide hardfacing that allows well retention device **170***a*/**170***b* to grip the inner diameter of the well (not shown). Those of ordinary skill in the art will appreciate that examples of well retention devices **170** may include dog slips, such as those used with other downhole tools. Specifically aspects of well retention device **170***a*/**170***b* will be discussed in detail with respect to FIGS. **6-9**, below.

Those of ordinary skill in the art will appreciate that while automatic packer **100** has been illustrated and discussed as having two extendable perforators **130***a*/**130***b*, in certain embodiments, automatic packer **100** may only have a single extendable perforator **130**. For example, in certain embodiments, it may only be necessary to perforate an area above or below the automatic packer **100**. In such an embodiment, only a single extendable perforator **130** may be used.

Referring to FIG. **6**, a cross-sectional view of an extendable perforator **130** disposed within a well **180** according to embodiments of the present disclosure is shown. In this embodiment, only the extendable perforator **130** of automatic packer (not shown) is illustrated disposed within a well **180**. The well **180** has an inner diameter well wall **185**, which defines the diameter of the well. Depending on the operation, the well wall **185** may be cased or uncased. In the operation of a cased well wall, the well wall may be formed from metal and/or metal allow tubulars cemented into place within the wellbore (not independently illustrated). In the case of an uncased wellbore, the well wall **185** may be formed from rock formation.

As illustrated, extendable perforator **130** is illustrated longitudinally within well **175**. By longitudinally expanding extendable perforator **130**, perforation charges **150** may be disposed at a desired position within well **180**. Those of ordinary skill in the art will appreciate that the orientation and spacing of perforation charges **150** may vary depending on the desired perforation effect upon detonation. For example, perforation charges **150** may be spaced in increments of inches, feet, or tens of feet, and wire **155** may space charges for several feet, tens or feet, or in certain occasions hundreds of feet longitudinally within the well **180**. Additionally, perforation charges **150** may be oriented, or angled on wire **155**, thereby allowing the charges to create tunnels into the formation at a desired orientation.

In order to hold extendable perforator **130** in an expanded condition within well **175**, a well retention device **170** may be disposed on a terminal end **175** of extendable perforator **130**. The well retention device **170** may include a plurality of projections (not shown) that are configured to engage the inner diameter of well wall **185**. As explained above, the plurality of projections may include teeth or an applied material that allows the well retention device to engage or grip into well wall **185**.

When extendable perforator **130** is stored in an extendable partition (not shown) of automatic packer (not shown), well retention device **170** may be in a closed position, such that arms **190** of well retention device **170** are collapsed. However, open release of extendable perforator **130** from the extendable partition (not shown) of automatic packer (not shown), the arms **190** may radially extend outwardly into engagement with well wall **185**.

In certain embodiments, arms **190** of well retention device **170** may be biased in an open position through use of a spring **195**. While extendable perforator **130** is stored within automatic packer (not shown), spring **195** may be compressed, and arms **190** may be unexpanded. When extendable perforator **130** is released from automatic packer (now shown), spring **195** may force arms radially outward until the arms **190** engage the well wall **185**. After arms **190** are radially expanded and into contact with well walls **185**, the wire **155** may be held taut within the well **180**, thereby holding extendable perforator **130** in a longitudinally expanded condition. In certain embodiments, one or more springs (not shown) may be used to keep the wire **155** in tension. In still other embodiments, one or more springs (not shown) may be used so that a portion of the wire **155** may be reeled back in, in order to keep wire **155** stretched outwardly. In certain embodiments, wire **155** may be extended into the well through use of an explosive, detonation, or rapid force release, which may be either hydraulic or pneumatic. For example, in one embodiment, a pressurized gas may be released, thereby providing outward thrust.

Referring also to FIG. **7**, a cross-sectional view of an extendable perforator **130** disposed within a well **180** according to embodiments of the present disclosure is shown. In this embodiment, only the extendable perforator **130** of automatic packer (not shown) is illustrated disposed within a well **180**. The well **180** has an inner diameter well wall **185**, which defines the diameter of the well. Depending on the operation, the well wall **185** may be cased or uncased.

As illustrated, extendable perforator **130** is illustrated longitudinally within well **180**. By longitudinally expanding extendable perforator **130**, perforation charges **150** may be disposed at a desired position within well **180**. In order to hold extendable perforator **130** in an expanded condition within well **180**, a well retention device **170** may be disposed on a terminal end **175** of extendable perforator **130**. The well retention device **170** may include a plurality of projections (not shown) that are configured to engage the inner diameter of well wall **185**. As explained above, the plurality of projections may include teeth or an applied material that allows the well retention device to engage or grip into well wall **185**.

When extendable perforator **130** is stored in an extendable partition (not shown) of automatic packer (not shown), well retention device **170** may be in a closed position, such that arms **190** of well retention device **170** are collapsed. However, open release of extendable perforator **130** from the extendable partition (not shown) of automatic packer (not shown), the arms **190** may radially extend outwardly into engagement with well wall **185**. In order to hold arms **190** in a biased open position, once released from automatic packer (not shown), one or more springs **195** may be disposed in contact with arms **190**.

In FIG. **7**, as opposed to FIG. **6**, arms **190** are shown expanding into contact with well wall **185**, such that retention angle α formed between well wall **185** and arm **190** is less than 90°. In such an embodiment, arms **190** move along well wall **185** until they engage well wall **185**, pulling wire **155** taut and thereby substantially longitudinally expanding extendable perforator **130**. Referring back to FIG. **7**, arms are shown expanding into contact with well wall **185**, such that retention angle β formed between well wall **185** and arm **190** is greater than 90°. In such a position, wire **155** is also allowed to longitudinally expand, thereby holding extendable perforator **130** in a substantially expanded condition.

Referring to FIGS. **8** and **9**, top cross-sectional views of well retention devices **170** within a well **180** according to embodiments of the present disclosure are shown. Referring specifically to FIG. **7**, in this embodiment, well retention device **170** is shown having a plurality of arms **190**. The plurality of arms **190** include solid portions **200** that is illustrated radially expanded. In certain embodiments, plurality of arms **190** may also have small perforations drilled or otherwise formed thereon that are configured to reduce drag forces acting thereon. The plurality of arms **190** may also have small perforation drilled or otherwise formed therein to reduce drag forces acting thereon. The solid portion **200** may be formed from, for example, various metals, metal alloys, polymers and/or composites. During actuation, well retention device **170** is released from automatic packer (not shown). The arms **190** extend radially outward into engagement with the well **180**. In order to increase the speed of deployment, and to facilitate moving extendable perforator (not independently show) within the well **180**, solids portions **200** may expand, thereby trapping fluid within the well **180**. The trapped fluid pressing against solid portions **200** may thus help pull the extendable perforator within the well **180**, facilitating the expansion of extendable perforator. In certain embodiments, solid portion **200** may resemble a parachute or wings that extend in order to allow substantially full expansion.

Depending on the requirements of the operation, the area of the well **180** that is covered by the solid portions **200** may vary. For example, in certain embodiments, the solid portion **200** may cover less than 10% of the cross-sectional well area. In other embodiments, the area covered by the solid portion **200** may range between 10% and 20%, between 20% and 30%, between 30% and 40%, between 40% and 50%, or greater than 50% of the cross-sectional well area. In still other embodiments, the solid portion **200** may cover less than 10% of the cross-sectional well area. In certain embodiments, solid portion **200** may include perforated holes (not shown) or with open slots (not shown) that may be sized in order to change drag resistance and setting speed of solid portion **200**. For example, in certain embodiments, the perforated holes may be adjustable, thereby allowing an operator to adjust the diameter of the slot, thereby changing the effect of drag on solid portion **200**. In certain embodiments, solid portion **200** may have one or more wings (not independently illustrated). For example, solid portion **200** may include two, three, four, or more wings. In certain embodiments, solid portion **200** may include a concave or convex geometry. Further still, solids portion **200** may include a geometry that is specifically shaped to change the effect of drag or specific setting parameters on solid portion **200**. For example, the geometry may be modified to increase a setting speed, slow a setting speed, provide a specific level of expansion, etc.

Depending on the requirements of the operation, the number of arms **190** may also vary. For example, as shown in FIG. **9**, well retention device **170** includes four arms, however, in other embodiments two arms, three arms, five arms, or more than five arms may be used. Similarly, the number of solid portions **200** may also vary according to the requirements of the operation. As illustrated, well retention device **170** includes two solid portions **200**. However, in alternative embodiments, one solid portion **200**, three solid portions **200**, four solid portions **200**, or greater than four solid portions **200** may be used. Those or ordinary skill in the art will appreciate that the number and area of solid portions **200** may affect the deployment speed of the extendable perforator. Thus, the number and area of solid portions **200** may vary according to the density of the fluid within the well **180**, the well pressure, well temperature, types of chemicals being used, and the like.

Referring to FIG. **10**, a cross-sectional view of an automatic packer **100** according to embodiments of the present disclosure is shown. In this embodiment, automatic packer **100** is shown without reference to specific packing elements, such as sealing elements, sensors, and the like. Rather, automatic packer **100** is shown with a telescoping extendable perforator **130**.

Automatic packer **100** includes a tool body **105** and a telescoping extendable perforator **130**. In the closed, unactuated position, as illustrated in FIG. **11**, the telescoping extendable perforator **130** is illustrated collapsed within the tool body **105** of automatic packer **100**. Telescoping extendable perforator **130** is illustrated having three telescopic portions, an outer portion **205**, a middle portion **210**, and a terminal portion **215**. While, telescoping extendable perforator **130** is illustrated having three telescopic portions, those of ordinary skill in the art will appreciate that less than three portions, or more than three portions may be used, depending on the length of area to be perforated and the number of perforation charges (not illustrated) that are required.

Referring to FIG. **11**, a side view of an automatic packer **100** in an actuated condition according to embodiments of the present disclosure is shown. In this embodiment, as with FIG. **10**, automatic packer **100** is shown without reference to specific packing elements, such as sealing elements, sensors, and the like. Rather, automatic packer **100** is shown with a telescoping extendable perforator **130**.

As illustrated, telescoping extendable perforator **130** has expanded longitudinally, thereby axially projecting outer portion **205**, middle portion **210**, and terminal portion **215** upward. Outer portion **205**, middle portion **210**, and terminal portion **215** may be held in place relative to one another through use of locking shoulders (not shown) that engage upon actuation. Thus, once longitudinally expanded, the outer portion **205**, middle portion **210**, and terminal portion **215** are locked in place in an expanded condition.

Each portion of telescoping extendable perforator **130** may include a plurality of perforation charges **150**. Depending on the requirements of the operation, the number of perforation chargers **150** as well as the spacing of the perforation charges on the telescoping extendable perforator may vary. Those of ordinary skill in the art having benefit of the present disclosure will appreciate that in certain embodiments, multiple telescoping extendable perforators **130** may be used on a single automatic packer **100**. For example, more than one telescoping extendable perforator **130** may expand axially upward, one or more telescoping extendable perforators **130** may expand axially downward, and/or one or more telescoping extendable perforators **130** may expand axially both upward and downward within a well. Because the orientation of the telescoping extendable perforators **130** maybe locked into place upon actuation, the orientation of perforation charges **150** may be controlled, thereby allowing for tunnels to be formed in the formation at desired angles and with a desired geometry.

Referring to FIG. **12**, a cross-sectional view of an automatic packer **100** according to embodiments of the present disclosure is shown. In this embodiment, automatic packer **100** is shown without reference to specific packing elements, such as sealing elements, sensors, and the like. Rather, automatic packer **100** is shown with a latitudinal telescoping extendable drilling mechanism **133**.

Automatic packer **100** includes a tool body **105** latitudinal telescoping extendable drilling mechanism **133**. In the closed, unactuated position, as illustrated in FIG. **12**, the latitudinal telescoping extendable drilling mechanism **133** is illustrated collapsed within the tool body **105** of automatic packer **100**. Latitudinal telescoping extendable drilling mechanism **133** is illustrated having three telescopic portions, an outer portion **205**, a middle portion **210**, and a terminal portion **215**. While, latitudinal telescoping extendable drilling mechanism **133** is illustrated having three telescopic portions, those of ordinary skill in the art will appreciate that less than three portions, or more than three portions may be used, depending on the length of area to be perforated and the number of perforation charges (not illustrated) that are required. Additionally, latitudinal telescoping extendable drilling mechanism **133** includes a drill bit **135** and a perforation charge **136**. In certain embodiments, extendable drilling mechanism **133** may also be formed from reeled coiled tubing or umbilical card that may be extended or reeled out during drilling. Such tubing may be formed from, for example, various metals, metal alloys, polymers and/or composites.

Referring to FIG. **13**, a side view of an automatic packer **100** in an actuated condition according to embodiments of the present disclosure is shown. In this embodiment, as with FIG. **10**, automatic packer **100** is shown without reference to specific packing elements, such as sealing elements, sensors, and the like. Rather, automatic packer **100** is shown with a latitudinal telescoping extendable drilling mechanism **133**. In this embodiment, latitudinal telescoping extendable drilling mechanism **133** includes a drill bit **135** disposed at the end thereof, as well as a perforation charge **136**.

During operation, a PLC (not specifically shown) connected to one or more sensors (not specifically shown) may actuate latitudinal telescoping extendable drilling mechanism **133**. Upon actuation, latitudinal telescoping extendable drilling mechanism **133** may latitudinally into the well. The perforation charge **136** may thus be detonated in proximity to a location of the well wall or casing that is to be perforated. The drill bit **134** may then be expanded into contact with the casing and one or more holes may be drilled therethrough. In certain embodiments, the drill bit **134** may be configured to continue drilling until the drill bit **134** wears out. In other embodiments, drill bit **134** may be configured to drill to a selected depth within the formation. Drill bit **134** may be actuated pneumatically, electronically, or hydraulically. After the drill bit **134** has drilled into the formation, the telescoping arms may extend therein and the perforation charges **150** may be detonated. Those of ordinary skill in the art will appreciate that each drill bit **134** may be configured to drill one or more holes into the formation. Thus, in certain embodiments, each drill bit **134** may be configured to drill into and thus detonate perforation charges **150** into one drilled hole, while in other embodiments, drill bit **134** may be configured to drill and thus provide perforations to two or more sections of the well.

Referring to FIG. **14**, a cross-sectional view of a cased wellbore according to embodiments of the present disclosure is shown. A wellbore **220** that is cased with a plurality of tubulars **225** is illustrated in FIG. **14**. During most casing operations, a plurality of tubulars **225** are placed in a wellbore **220**, and the plurality of tubulars **225** are then cemented into place. While the tubulars have a known inner diameter **230**, the connection point **235**, where two tubular sections **225** are jointed together, e.g., coupled, will have a slightly different inner diameter. The inner diameter **240** of tubular connection point **235** is generally slightly larger than the inner diameter **230** of tubular sections **225**. For example, in conventional casing the difference between inner diameter **230** of tubular sections **225** and inner diameter **240** of tubular connection point **235** may range between less than about 0.5 mm and about 2.0 mm.

Referring to FIG. **15**, a cross-sectional view of a well **245** during deployment of an automatic packer **100** according to embodiments of the present disclosure is shown. During deployment, an automatic packer is disposed in a well **245**. The automatic packer may include a tool body (not independently referenced), at least one sensor (not shown), at least one sealing element (not shown), as well are various other components, such as those discussed above. Cased well **245** includes a plurality of tubulars **225** that have been cemented into place within the wellbore **220**. As explained above, the tubulars **225** have an inner diameter **230**, while the tubular connection point **235** has a second slightly larger diameter **240**.

As automatic packer **100** moves in direction A within well **245**, sensors (not shown), such as calipers or ultrasonic sensors, measure the inner diameter within the well **245**. By measure the difference between inner diameter **230** and inner diameter **240**, the sensor can calculate the number of tubular sections **225** through which automatic packer **100** has passed. Because the length of tubular sections **225** is known, the depth of automatic packer **100** at any given time can be determined. Other methods to measure a distance or a depth by the sensors may include a casing collar locator, tachometer, temperature, and/or pressure gradient.

Prior to deploying automatic packer **100** in well **245**, automatic packer **100** can be configured to deploy at a selected depth. For example, if a production zone is located at 2000 feet, automatic packer **100** may be set to actuation at a desired location below 2000 feet, thereby isolating the production zone from the rest of the well **245**. While actuation based on position is discussed in detail herein, those of ordinary skill in the art having the benefit of the present disclosure will appreciate that other preselected parameters may also be used to automatically actuation automatic packer **100**. For example, if the pressure at a given location within a well **245** is known, automatic packer **100** may be configured to actuate when a sensor reads the selected pressure. Similarly, if a temperature is known at a location within the well **245**, automatic packer **100** may be configured to automatically actuate when the sensors measure the selected temperature. In certain embodiments, if the number of tubular sections within well **245** is known, automatic packer **100** may be configured to automatically actuation when, for example, a casing collar locator sensor measures a depth based on the number of tubular sections.

Referring to FIG. **16**, a cross-sectional view of automatic packer **100** within a well **245** according to embodiments of the present disclosure is shown. As illustrated, automatic packer **100** has passed through a specified depth as preselected by an operator prior to deployment. Upon passing through the preselected depth measured by the sensors (not independently shown), automatic packer **100** actuates, thereby causing sealing elements **110** to radially expand into contact with well wall **185**. In certain embodiments, a PLC may determine that the falling velocity of automatic packer **100** is too high. In such a situation, automatic packer **100** may be configured to deploy a small parachute (not shown), such as those described above with respect to the aforementioned solid portion. Alternatively, one or more dog slips (not shown) or other mechanical gripping device may be actuated in order to contact the well wall, such that the drag/friction slows down the decent of automatic packer **100**. After actuation, well **245** is divided into a top well partition **250** and a bottom well partition **255**.

In certain embodiments, isolation of a section of well **245** may be the entire operation automatic packer **100** is configured to do. In such an embodiment, top well partition **250** and or bottom well partition **255** may be chemically treated, casing may be repairs, offsets may be drilled, or other actions may be performed that requires sectional isolation. However, in certain embodiments, automatic packer may also be capable of performing an automatic perforation, which is discussed below with respect to FIG. **18**.

Referring to FIG. **17**, a cross-sectional view of an automatic packer **100** in a well **245** according to embodiments of the present disclosure is shown. After actuation of automatic packer **100**, thereby radially expanding sealing elements **110**, a second signal may be sent from sensor (not shown) or data controller (not shown) triggering deployment of extendable perforator **130**. As explained above with respect to FIG. **5**, extendable perforator **130** may be released from automatic packer **100** and allowed to travel longitudinally upward into well **245**.

Extendable perforator **130** includes a wire **155** onto which a plurality of perforation charges **150** are disposed. Extendable perforator **130**, in this embodiment, also includes a well retention device **170**. As illustrated, extendable perforator **130** may expand longitudinally along the axis of the well **245** prior to detonation of perforation charges **150**.

Referring to FIG. **18**, a cross-sectional view of an automatic packer **100** in a well **245** according to embodiments of the present disclosure is shown. Fluid flow within well **245** pushes extendable perforator **130** longitudinally upward. In certain embodiments, extendable perforator **130** may be pushed upwardly through use of a mechanical thrust activator (not shown). As illustrated, expanded arms **190** of well retention device **170**, as well as solid portions (not shown) facilitate the expansion of extendable perforator **130**. When wire **155** of extendable perforator **130** is substantially fully extended longitudinally within well **245**, the well retention device **170** engages the inner wall of well **245**, thereby holding and locking extendable perforator **130** into place. In an expanded position, perforation charges **150** may be spaced within the well **245** as desired by the operator.

After expansion of extendable perforator **130**, the perforation charges **150** may be detonated in order to perforate the well **245**.

Referring to FIG. **19**, a cross-sectional view of an automatic packer **100** in a well **245** according to embodiments of the present disclosure is shown. After actuation of automatic packer **100**, thereby radially expanding sealing elements **110**, a second signal may be sent from sensor (not shown) or data controller (not shown) triggering deployment of extendable perforator **130**. As explained above with respect to FIG. **5**, extendable perforator **130** may be released from automatic packer **100** and allowed to travel longitudinally upward into well **245**.

Each extendable perforator **130** includes a wire **155** onto which a plurality of perforation charges **150** are disposed. Extendable perforators **130**, in this embodiment, also include a well retention device **170**. As illustrated, extendable perforators **130** may expand longitudinally along the axis of the well **245** prior to detonation of perforation charges **150**.

Similar to FIG. **17**, the automatic packer **100** of FIG. **19** includes two extendable perforators **130**. The top extendable perforator **130*a*** is configured to extend longitudinally upward within the well **245**, while bottom extendable perforator **130*b*** is configured to extend longitudinally downward within the well **245**.

Referring to FIG. **20**, a cross-sectional view of an automatic packer **100** in a well **245** according to embodiments of the present disclosure is shown. Fluid flow within well **245** pushes extendable perforator **130*a*** longitudinally upward. In a condition where automatic packer **100** is set before actuation of extendable perforator **130*a***, a force may be applied to extendable perforator **130*a***, thereby forcing extendable perforator **130*a*** upwardly. Examples of forces that may be applied may include springs in tension, release of a pressurized gas or other fluid, pneumatic movement, detonation, etc. As illustrated, expanded arms **190** of well retention device **170**, as well as solid portions (not shown) facilitate the expansion of extendable perforator **130**. When wire **155** of extendable perforator **130** is substantially fully extended longitudinally within well **245**, the well retention device **170** engages the inner wall of well **245**, thereby holding and locking extendable perforator **130*a*** into place. In an expanded position, perforation charges **150** may be spaced within the well **245** as desired by the operator.

Fluid flow as well as gravity forces extendable perforator **130*b*** longitudinally downward within well **245**. As illustrated, expanded arms **190** of well retention device **170**, as well as solid portions (not shown) facilitate the extension of extendable perforator **130**. When wire **155** of extendable perforator **130** is substantially fully extended longitudinally within well **245**, the well retention device engages the inner wall of well **245**, thereby holding and locking extendable perforator **130*b*** into place. In an expanded position, perforation charges **150** may be spaced within the well **245** as desired by the operator.

After expansion of extendable perforators **1301**/**130*b***, the perforation charges **150** may be detonated in order to perforate the well **245**.

Referring to FIG. **21**, a cross-sectional view of a well **245** having multiple isolated zones according to embodiments of the present disclosure is shown. In this embodiment, three automatic packers **100*a***, **100*b***, and **100*c***, are deployed in a well **245**. Automatic packer **100*a*** divides a top partition **250**, automatic packer **100*b*** divides a first middle partition **256** from a second middle partition **257**, and automatic packer **100*c*** divides second middle partition **257** from bottom partition **255**. In such an embodiment, the well **245** is divided into four discrete and isolated zones, **250**, **256**, **257**, and **255**, from which separate perforation operations may be performed.

As explained above, automatic packers **100*a***, **100*b***, and **100*c***, each have at least one extendable perforator **130**. Each extendable perforator **130** has a wire **155** with a plurality of charges **155**. Additionally, the extendable perforators **130** have well retention devices **170**.

During operation, automatic packer **100*c*** was initially disposed in the well **245**. Automatic packer **100*b*** was deployed second, and automatic packer **100*a*** was deployed last. Depending on the requirements of the operation, one or more of automatic packers **100** may be deployed at the same time, each with a different preselected actuation depth or other actuation criteria, such as, for example, casing collar locators/position, tachometer measurements, temperature, pressure, etc. Upon reaching the preselected depth, automatic packer **100*c*** actuates, radially expanding sealing element **110** into engagement with well wall **185**. Automatic packers **100***b* and **100***a* also fell within the well **245** to different preselected depths before actuating. Depending on the preselected depth differences between the automatic packers **100**, automatic packer **100***a* may actuate before automatic packer **100***b* and/or **100***c* reaches its respective preselected actuation depth. The order of actuation is not significant, as the automatic actuation will allow each automatic packer **100** to fall freely to its individual preselected depth prior to actuation.

After actuation of automatic packers **100***a*, **100***b*, and **100***c*, actuation of extendable perforators **130** may occur. Depending on the requirements of the operation, the individual extendable perforators **130** may occur directly after actuation of sealing elements **110**. In other embodiments, extendable perforators **130** may actuate a set time period after sealing elements. In still other embodiment, extendable perforators **130** may actuate on a different measured criteria. For example, in one embodiment, sealing elements **110** of automatic packers **100** may actuate based on a position indicator, which extendable perforators **130** may actuate based on a pressure differential or a measured pressure. In still other embodiments, both sealing element **110** actuation and extendable perforator **130** actuation may occur at substantially the same time. For example, in such an embodiment, the actuation of sealing element **110** may cause the deployment of extendable perforator **130**. In still another embodiment, extendable perforator **130** may deploy first, with the actuation of sealing elements **110** following thereafter.

In certain embodiments, extendable perforators **130** may actuate on an external device or through wireless transmission. For example, during a hydraulic fracture job, a ball may be dropped from the surface with a unique transmitting signal, size, shape, or magnetic actuation, which when the PLC in the automatic packer **100** senses or receives, the PLC determines it may actuate automatic packer **100**. For example, the PLC may control automatic packer **100** to deploy extendable perforator **130**, isolate a section of the well, or provide another specific action. In still another embodiment, the automatic packer **100** may be actuated through a wireless transmission from the surface or from an e-line lowered into the well, thereby providing a wireless signal to one or more of the packers **100**.

As illustrated, automatic packer **100***a* includes one extendable perforator **130** that extends into top partition **250**. Automatic packer **100***b* includes two extendable perforators **130**, one extends upwardly into first middle partition **256**, while a second extendable perforator **130** extends downwardly into second middle partition **257**. Automatic packer **100***c* includes one extendable perforator **130** that extends downwardly into bottom partition **255**. Those of ordinary skill in the art will appreciate that the specific design variations of automatic packers **100** and extendable perforators **130** may vary according to design considerations for a specific operation.

After automatic packers **100** are deployed and actuated, one or more of the partitions **250**, **255**, **256**, and/or **257** of the well **245** may be perforated. Those of ordinary skill in the art will appreciate that the individual zones maybe perforated at the same time or at different times, depending on the production schedule for the well **245**.

Referring to FIG. **22**, a cross-sectional view of an automatic packer **100** disposed in a wellbore according to embodiments of the present disclosure is shown. In this embodiment, automatic packer **100** includes a tool body **105**, a sealing element **110**, and sensors (not shown). Automatic packer **100** may also include other various components necessary to actuate or control automatic packer **100** such as, for example, a data controller (not shown), a wireless transmitter (not shown), wiring (not shown), dogs (not shown), slips (not shown), etc. Automatic packer **100** also includes a motive device **300**, disposed on tool body **105**. As illustrated, motive device **300** is a tractor design that includes a plurality of wheels **305** held in place by a track (not specifically illustrated). In other embodiments, motive device may include wheels, propellers, rotating teeth, or any other device that is configured to move automatic packer **100** within a wellbore **220**.

Automatic packer **100** have a motive device **300** may be useful in wellbores **220** that have deviated sections or lateral sections. In certain wellbores **220**, the path of the wellbore **220** is not straight. Thus, there may be a number of undulating sections that move both laterally and longitudinally. In certain sections, the path of the wellbore **220** may even require the automatic packer **100** to travel upwardly to reach a desired place within the wellbore **220**. In such wellbores **220**, traditional packers without motive devise **300** may not be capable of reaching such sections because gravity or even fluid flow into the wellbore **220** may not be sufficient to carry automatic packer **100** to the desired location. In such a wellbore **220**, automatic packer **100** having motive device **300** may be used to ensure automatic packer **100** is capable of reaching the desired location.

Motive device **300** may be controlled from the surface of the wellbore **220** using a wireless transmission tied into the data controller. In other embodiments, automatic packer **100** may be configured to actuate at a predefined depth. For example, automatic packer **100** may use one or more sensors to determine the packers place within the wellbore **220**. When automatic packer **100** reaches the predefined location, as measured by the sensors, automatic packer **100** may actuate. Actuation of automatic packer **100** may include setting the sealing elements **110** to isolate a portion of the wellbore **220** or may include actuating a perforation device (not shown), as discussed in detail below. Those of ordinary skill in the art will appreciate that a motive device **300** as explained herein may be used on any of the other embodiments of automatic packer **100** discussed herein.

In certain embodiments, motive device **300** may be used to recharge the batteries of automatic packer **100** through the kinetic motion generated by automatic packer **100**. In other embodiments, motive device **300** may rely on the batteries of automatic packer **100** in order to operate. In still other embodiments, motive device **300** may have batteries separate from the batteries of automatic packer **100**, thereby allowing the motive device **300** to operate independently from automatic packer **100**, which is discussed further below.

Referring to FIG. **23**, a cross-sectional view of an automatic packer **100** disposed in a wellbore according to embodiments of the present disclosure is shown. In this embodiment, automatic packer **100** includes a tool body **105**, a sealing element **110**, and sensors (not shown). Automatic packer **100** may also include other various components necessary to actuate or control automatic packer **100** such as, for example, a data controller (not shown), a wireless transmitter (not shown), wiring (not shown), dogs (not shown), slips (not shown), etc. Automatic packer **100** also includes a motive device **300**, disposed on tool body **105**.

As illustrated in FIG. **23**, automatic packer **100** is shown after actuation. In this embodiment, after sensors (not shown) determined automatic packer **100** reached the predefined location within wellbore **220**, the sealing elements

110 were radially expanded into contact with the wellbore 220 walls, thereby isolating the wellbore into a top portion 310 and a bottom portion 315. After actuation, automatic packer 100 may stay within the wellbore 220, however, motive device 300 may be disconnected from tool body 105 and returned to the surface. In this embodiment, motive device 300 was disconnected from tool body 105 after actuation of sealing elements 110, however, in other embodiments, motive device 300 may be disconnected from tool body 105 prior to the actuation of sealing elements 110. Motive device 300 may return to the surface of wellbore 220 through natural flow of fluids within the wellbore, or may be pulled to the surface using wireline, coiled tubing, or the like. In still other embodiments, motive device may be returned to the surface using the motive abilities of motive device 300. Because motive device 300 may be returned to the surface of the wellbore 220, motive device 300 may be reused in other packer actuation implementations.

Referring to FIG. 24, a cross-sectional view of an automatic packer 100 disposed in a wellbore according to embodiments of the present disclosure is shown. In this embodiment, automatic packer 100 includes a tool body 105, a sealing element 110, and sensors (not shown). Automatic packer 100 may also include other various components necessary to actuate or control automatic packer 100 such as, for example, a data controller (not shown), a wireless transmitter (not shown), wiring (not shown), dogs (not shown), slips (not shown), etc. Automatic packer 100 also includes a drill bit 320 disposed at a lead end 322 of automatic packer 100.

In certain wellbore 220, an obstruction 325 may form at some point within the wellbore 220 that may prevent a downhole tool, such as automatic packer 110, from reaching a desired target location. Obstructions 325 may be formed from rock fragments, perforation fragments, scale build up, etc., and may be located on the walls of the wellbores 220 or within the central flow bore of the wellbore 220. Depending on the size of the obstructions 325, the obstructions 325, in additional to preventing automatic packer 100 from reaching a desired location, may restrict the flow of fluids therethrough.

As indicated above, in this embodiment automatic packer 100 includes a drill bit 320 that is configured to drill out such obstructions 325 as automatic packer 100 is run into the wellbore 100. FIG. 24 illustrates drill bit 320 in a contracted or non-actuated condition. In this condition, drill bit 320 includes a restricted diameter to prevent the drill bit 320 from contracting the walls of the wellbore 220. Drill bit 320 may include various types of drill bits 320 that are known in the art including, for example, fixed cutter (drag) bits and roller cone bits. While not explicitly shown, fixed cutter bits may include various inserts, such as tungsten carbide inserts that are press fit or brazed into the body of the bit. Such inserts may include a diamond or polycrystalline diamond layer, applied thereto, that increasing the cutting potential of the bit. Those of ordinary skill in the art will appreciate that such inserts may be disposed on fixed cutter bits having particular back and side rakes in order to optimize the cutting action of the specific inserts.

Similarly, roller cone style drill bits may be used according to embodiments of the present disclosure. Roller cone style drill bits may include one, two, three, or more cones, with each cone having a plurality of inserts disposed thereon. As with fixed cutter drill bits, the inserts of roller cone drill bits may be press fit or brazed into the individual cones and each cone and insert may be configured to optimize the cutting action of the bit. For example, inserts of various geometries may be used with roller cone bits to further increase the cutting action of the roller cone bit.

In addition to fixed cutter and roller cone drill bits, other types of drill bits may be used according to embodiments of the present invention. For example, a reamer style bit may be used in embodiments of automatic packer 100. Traditional reamers include radially expandable arms housing a plurality of cutting sections or cutting elements that are configured to cut through formation or other obstructions 325. The arms of reamers may be configured to expand in one or more directions, such as into contact with the sidewalls of a wellbore 220, thereby allowing the cutting elements that are disposed thereon to contact an obstruction 325. Those of ordinary skill in the art will appreciate that the types of drill bits 320 discussed herein are merely exemplary and any type of drill bit 320 may be disposed on automatic packer 100.

Referring to FIG. 25, a cross-sectional view of an automatic packer 100 disposed in a wellbore according to embodiments of the present disclosure is shown. In this embodiment, automatic packer 100 includes a tool body 105, a sealing element 110, and sensors (not shown). Automatic packer 100 may also include other various components necessary to actuate or control automatic packer 100 such as, for example, a data controller (not shown), a wireless transmitter (not shown), wiring (not shown), dogs (not shown), slips (not shown), etc. Automatic packer 100 also includes a drill bit 320 disposed at a lead end 322 of automatic packer 100.

FIG. 25 shows automatic packer 100 that has encountered an obstruction 325 and actuated drill bit 320. As illustrated, drill bit 320 has radially expanded, thereby allowing drill bit to substantially fill the diameter of wellbore 220, thereby allowing obstruction 325 to be substantially removed. Drill bit 320 may be expanded through various techniques. For example, in one embodiment, drill bit 320 may be held in a collapsed or closed position through the use of, for example, lock rings, collapsed teeth, springs, or the like. When an obstruction 325 is encountered, automatic packer 100 may release drill bit 320, thereby allowing drill bit 320 to expand into an open or uncollapsed position. In order to release drill bit 320 from a closed position, automatic packer 100 may cause a burst or rupture disk to break, thereby releasing drill bit 320. In still other embodiments, hydraulic pressure may be used to release and/or hold drill bit 320 in an open position. In still other embodiments, an electric signal may be sent by automatic packer 100 to cause drill bit 320 to move into an open position. Those of ordinary skill in the art will appreciate that once open, drill bit 320 may remain in an open position. In other embodiments, automatic packer 100 may issue a second command to retract drill bit 320 into a closed position after the obstruction 325 is cleared.

Referring to FIG. 26, a cross-sectional view of an automatic packer 100 disposed in a wellbore according to embodiments of the present disclosure is shown. In this embodiment, automatic packer 100 includes a tool body 105, a sealing element 110, and sensors (not shown). Automatic packer 100 may also include other various components necessary to actuate or control automatic packer 100 such as, for example, a data controller (not shown), a wireless transmitter (not shown), wiring (not shown), dogs (not shown), slips (not shown), etc. Automatic packer 100 also includes a drill bit 320 disposed at a lead end 322 of automatic packer 100.

FIG. 26 shows drill bit 320 clearing obstruction 325. Drill bit 320 may clear obstruction 325 by rotating in order to cut through the obstruction, or, depending on the type of obstruction **325**, contact alone without rotation may be enough to clear the obstruction **325**. Rotation of drill bit **320** may include rotation of automatic packer **100**, or drill bits **320** may rotate independent from automatic packer **100**. In certain embodiments, automatic packer **100** having a drill bit **320** may also benefit from being disposed in wellbore **220** through use of a motive device (**300** in FIG. **22**). In such an embodiment, the motive device may be used to rotate drill bit **320** and/or automatic packer **100**.

In certain embodiments, the data controller or PLC of the automatic packer **100** may be connected to one or more sensors in order to detect when an obstruction **325** exists. The data controller/PLC along with the sensors may also be used to determine when the obstruction **325** has been cleared.

Referring to FIG. **27**, a schematic representation of an automatic packer according to embodiments of the present disclosure is shown. FIG. **27** provides a schematic overview of the different actuations that an automatic packer may be configured for. Those of ordinary skill in the art will appreciate that not every function much be present on every embodiment. In certain embodiments, the automatic packer may be used to achieve one goal, while in other embodiments, the automatic packer may have a number of different responsibilities while downhole.

Unlike existing packers that serve a single function of being run into a wellbore than then actuated to isolate a portion of the wellbore, the automatic packer disclosed herein includes a programmable logic controller (PLC) that includes, for example, a microprocessor and a memory (**400**). The memory may be used to store data that is gather downhole or may be used to store instructions for causing the automatic packer to perform specific functions downhole. For example, the PLC may be used to automatic cause the automatic packer to actuate sealing elements at a particular location within a wellbore. PLC may also be used to drive a motive device to a particular location within a wellbore, deploy a perforator at a desired location, or to control other devices.

PLC is connected to a power supply (**405**), which may also be connected to a battery recharge system (**410**). The power supply (**405**) may include a battery, such as a rechargeable lithium ion battery, that powers the PLC while the automatic packer is in the wellbore. The battery recharge system (**410**) may provide recharge to the battery through, for example, downhole heat induction, flowing phases through a turbine or turbine blades, kinetic recharging, movement, etc. Those of ordinary skill in the art will appreciate that any type of recharging system may be used to recharge the power supply while the automatic packer is downhole. Additionally, in certain embodiments, the battery recharge system may be configured to connect to a wellbore surface power supply through wires, thereby allowing the automatic packer to be powered from the surface or to allow the power supply to be recharged from the surface.

The automatic packer also includes one or more sensor assemblies (**415**). The sensor assemblies may include sensors for measuring a temperature, a pressure, a fluid type, a density, a specific gravity, an induction, a conduction, a refraction, infrared signal, a fiber optic signal, a load, an acceleration, a velocity, an ultrasonic signal, a tachometer measurement, a wireless transmission, a gyroscopic measurement, a casing collar locator measurement, various types of logging tools, imaging tools, modular formation dynamic testing tools, a modular reservoir dynamic test measurement, and/or a position within the well. The sensor assemblies (**415**) may be connected directly to the PLC (**400**), thereby allowing the PLC to know the conditions in the wellbore that may affect the automatic packer. Based on the measurements of the sensor assemblies (**415**), the PLC may carry out predefined instruction, thereby allowing the automatic packer to act independently from the surface of the wellbore.

As explained in detail above, the automatic packer disclosed herein is capable of performing a number of different actuations while downhole. Because the automatic packer is equipped with a PLC (**400**) capable of automatically actuating different aspects of the automatic packer, the automatic packer is capable of performing number functions during a single trip into a wellbore. PLC may be used to control a motive device (**420**) of the automatic packer. For example, the PLC may be programmed with instructions to drive to a particular depth within a wellbore. The motive device (**420**) may be actuated by the PLC (**400**) to start going down within a wellbore. The sensor assemblies (**415**) may substantially continuously measure the progress of the automatic packer within the wellbore. When the sensor assemblies (**415**) measure the desired depth, the PLC (**400**) may send a control signal to the motive device (**420**) effectively telling the movement to stop. Thus, PLC (**415**) may be used to control the depth to which the automatic packer progresses within a wellbore.

The automatic packer may also include one or more sealing elements (**425**). When sensor assemblies (**415**) provide information to PLC (**400**) indicating a predefined location for deployment has occurred, the PLC (**400**) may actuate sealing elements (**425**), thereby isolating a portion of the wellbore. Similarly, the PLC (**400**) may be used to actuate one or more perforators (**430**). As explained above, the PLC (**400**) may include instructions to both expand the perforators (**430**) as well as instructions that cause the perforators (**430**) to detonate at a particular location.

In addition to sealing and perforating a wellbore, the PLC (**400**) may also be used to control other devices (**435**). For example, PLC (**400**) may be used to control a drilling operation of the automatic packer. As previously explained in detail, automatic packer may be equipped with one or more different types of drill bits. In one embodiment, the PLC (**400**) may be used to control a laterally drilling drill bit that is capable of drilling and placing perforation charges. In other embodiments, PLC (**400**) may be used to actuate and drill out an obstruction in the wellbore. In either case, PLC (**400**) may use inputs from the sensor assemblies (**415**) in order to determine when and where to drill. Those of ordinary skill in the art will appreciate that PLC (**400**) may also be used to control other devices (**435**) that may be disposed on the automatic packer.

PLC (**400**) may also be used to transfer data (**440**). For example, in one embodiment, the automatic packer may be disposed downhole at a desired depth and actuated to seal the wellbore. The sensor assemblies (**415**) may then be used to gather data about the sealed section of the wellbore. When the desired data is acquired, PLC (**400**) may instruct the automatic packer to provide a data transfer (**440**), thereby sending the acquired data to the surface. The data transfer (**440**) may use a wireless connection, or alternatively, may be sent through wires or drill pipe that is connected to the surface.

PLC (**400**) may thus be used to both receive and send control signs for controlling the operations of the automatic packer downhole. In addition to controlling the actions of the automatic packer while downhole, the PLC (**400**) may be configured to receive control signals from the surface that change the instructions or functionality of the automatic packer. For example, based on the data gathered by the automatic packers while downhole, a control signal from the surface may be sent to PLC (**400**) providing instructions for performing another downhole operation. Examples of downhole operations that may be modified include sealing a different section of the wellbore, moving to a different location to perform data gathering, perforating a section of a wellbore, drilling a section of a wellbore, and the like. Because the automatic packer has a PLC (**400**) that allows data to be sent and received, a wellbore engineer at the surface may have greater control over aspects of the operation. For example, based on the information gathered by the automatic packer and sent to the surface, one or more wellbore parameters may be adjusted. Examples of wellbore parameters that may be adjusted in response to data gathered by the automatic packer include, a fluid flow rate, a fluid type, a type of perforation, a production interval, a production location, etc.

According to still other embodiments of the present invention, the downhole tool my not include the same components as the automatic packer, described above. For example, in certain embodiments, the downhole tool may be an automatic driller. Automatic drillers, according to embodiments of the present disclosure are discussed in detail below.

Referring to FIG. **28**, a side cross-sectional view of an automatic driller according to embodiments of the present disclosure is shown. In this embodiment, automatic driller **500** includes a tool body **505**. Tool body **505** may be formed from various metals, metal alloys, polymers, composites, and combinations thereof. For example, in one embodiment, tool body **505** may be formed from a ductile or malleable metal or metal alloy, thereby allowing the tool body **505** to flex under tensile or compressive stress. The plasticity of tool body **505** may thereby allow tool body **505** to flex during operation of automatic driller **500** such that tool body **505** and thus automatic driller **500** may conform to the profile of a well. Similarly, tool body **505** may be formed from various polymers and/or composites having sufficient plasticity to allow tool body **505** and thus automatic driller **500** to conform to the profile of a well. In certain embodiments, tool body **505** may have relatively high tensile strength and be sized smaller than the inner diameter of the downhole tubulars or open hole wellbore.

Automatic driller **500** also includes a motive device **510**. As explained above with respect to embodiments of the automatic packer, motive device **510** may include a plurality of wheels **515** or tracks (not independently shown). The wheels **515** may roll along the inner diameter of a well, or casing (if the well is cased or open hole), thereby allowing automatic driller **500** to move independently within a well. In still other embodiments, rather than wheels or tracks, the motive device **510** of automatic driller **500** may include a plurality of single or double rotating dog slips on each of automatic driller **500**. The wheels may be formed from various metals, metal alloys, polymers, composites, rubbers, and combinations thereof. For example, in one embodiment, wheels may be formed from a rubber or rubber compound disposed around a metal or polymer frame (not independently shown). In this embodiment, automatic driller **500** is illustrated as having two sets of motive device **510**, however, in other embodiments, automatic driller **500** may have more than two sets of motive devices. For example, automatic driller **500** may have three, four, five, or more sets of motive devices **510** concentrically disposed around tool body **505**. The number of motive devices **510** may depend on the diameter of the well, the operational parameters of automatic driller **500**, and/or the operational requirements for a particular automatic driller **500**.

Automatic driller **500** further includes a drill bit **520** disposed at a distal end **523** of tool body **505**. Various types of drill bits **520** may he used according to embodiments of the present disclosure. Examples of drill bits **520** that may be disposed on tool body **505** include polycrystalline diamond compact drill bits ("PDC bit"), also known in the art as fixed-cutter bits and/or drag bits. PDC bits include a plurality of cutters (not independently shown) that shear formation or other substances with a substantially continuous scraping motion. Cutters are typically formed from synthetic or natural diamond, which are disposed on a cone (notindependently shown). The cone is rotated relative to tool body **505** so that the cutters shear formation or other downhole substances.

In addition to PDC drill bits, drill bit **520** may also include a roller cone drill bit. Roller cone drill bits include one or more roller cones having a plurality of cutters disposed thereon. In certain embodiments, a roller cone drill bit may include one, two, three, or more cones that intermesh, thereby causing the tool to crush formation or other substances. During operation, the cones of the roller cone drill bit are rotated along the bottom of a well. As the cones rotate, the cutters contact the formation or other substance, crushing the formation or other substance and allowing the crushed substance to be removed from the bottom of the well. Examples of roller cone bits may include steel milled-tooth bits as well as carbide insert bits. The cutters of roller cone drill bits may be formed from metal and metal alloys, carbide, diamond, and other materials. Examples of types of cutters may include tungsten carbide cutters, diamond enhanced cutters, and cutters formed from other ultra-hard materials.

Drill bit **520** may also be capable of being collapsed within tool body **505**. In such an embodiment, drill bit **520** may be supported by one or more springs (not shown) disposed within tool body **505**. In certain embodiments, rather than springs, alternative mechanical, electrical, hydraulic, pneumatic, or pressurized locking/expandable mechanisms may be used. While collapsed, either entirely or partially within tool body, the spring may be in compression. Upon actuation, the spring may be released, thereby allowing drill bit **520** to expand out of tool body **505**. In certain embodiments, in addition to drill bit **520** being collapsible within tool body **505**, drill bit **520** may be radially compressible. In such an embodiment, in a run-in-hole state, drill bit **520** may have a smaller outer diameter than in an operational state. For example, as automatic driller **500** is run-in-hole, the drill bit may have an outer diameter such that the drill bit **520** may fit partially or entirely within tool body **505**.

During an operational state, the drill bit **520** may be radially expanded, thereby increasing the outer diameter of drill bit **520** to substantially match the inner diameter of a well. In order to radially compress drill bit **520**, one or more springs may hold drill bit **520** in compressed, run-in-state prior to actuation of automatic driller **500**. Release of the springs may thereby allow drill bits **520** to radially expand to an operational state. Those of ordinary skill in the art will appreciate that in other embodiments, drill bit **520** may be collapsed and/or compressed without the use of springs or other mechanically restrictive devices. In such embodiments, drill bit **520** may remain collapsed and/or compressed prior to pneumatic or hydraulic actuation of automatic driller **500**. Thus, in certain embodiments, drill bit **520** may remain collapsed and/or compressed prior to a fluid being used to actuate drill bit **520**.

Automatic driller **500** may also include one or more setting tools **525**. Setting tools **525** may include radially expandable projections that are configured to hold automatic driller **500** in place during operation. Setting tools **525** will be discussed in detail below during discussion of the operation of automatic driller **500**. However, generally, setting tools **525** may be formed from metals, metal alloys, polymers, and or composites, and may be configured to expand from tool body **505** into contact with a well or well casing. The setting tools **525** may include a plurality of teeth (not independently shown) that are configured to grip the inner diameter of the well or well casing, thereby holding automatic driller **500** in a desired position or orientation during automatic driller actuation. In this embodiment, automatic driller **500** includes two setting tools **525**, however, those of ordinary skill in the art will appreciate that in other embodiments, automatic driller **500** may include one, two, three, four, or more setting tools **525**.

Automatic driller **500** may also include various other components that allow automatic driller **500** to operate downhole independently. As discussed above with respect to the automatic packer, automatic driller **500** may include a rechargeable battery (not independently shown), a computer, such as a data controller or a programmable logic controller ("PLC") (not independently shown), a memory storage device (not independently shown), a wireless transmitter or transceiver (not independently shown), and multiple sensors (not independently shown). Examples of sensors that may be included with automatic drill **500** include sensors that may measure a temperature, a pressure, a fluid type, specific gravity spinner, induction, conduction, refraction, infrared, a load, an acceleration, a velocity, a fiber optic signal, an ultrasonic signal, a tachometer measurement, a wireless transmission, a gyroscopic measurement, a casing collar locator, various type of logging tools, imaging tools, modular formation dynamic testing tools, a modular reservoir dynamic test, and/or a position within the well. Generally, those of ordinary skill in the art will appreciate that the sensors may be used to determine a location of the automatic driller **500** within a well, as well as determine whether obstructions may exist within the well. If an obstruction is located, the automatic driller **500** may be actuated in order to clear the obstruction from the well. Additionally, the sensors may be used to determine the location of automatic driller **500** within a well, thereby allowing a secondary borehole to be cut or sidetracked from the well. The operation of automatic driller **500** is discussed in detail below.

Referring to FIG. **29**, a side cross-sectional view of an automatic driller **500** according to embodiments of the present disclosure is shown. In this embodiment, automatic driller **500** includes a tool body **505**. Tool body **505** may be formed from various metals, metal alloys, polymers, composites, and combinations thereof. For example, in one embodiment, tool body **505** may be formed from a ductile or malleable metal or metal alloy, thereby allowing the tool body **505** to flex under tensile or compressive stress. The plasticity of tool body **505** may thereby allow tool body **505** to flex during operation of automatic driller **500** such that tool body **505** and thus automatic driller **500** may conform to the profile of a well. Similarly, tool body **505** may be formed from various polymers and/or composites having sufficient plasticity to allow tool body **505** and thus automatic driller **500** to conform to the profile of a well. In certain embodiments, tool body **505** may have relatively high tensile strength and be sized smaller than the inner diameter of the downhole tubulars or open hole wellbore.

Automatic driller **500** also includes a motive device **510**. As explained above with respect to embodiments of the automatic packer, motive device **510** may include a plurality of wheels **515** or tracks **530**. In still other embodiments, rather than wheels or tracks, the motive device **510** of automatic driller **500** may include a plurality of single or double rotating dog slips on each of automatic driller **500**. In this embodiment, motive device **510** includes a plurality of wheels **515** disposed on tracks **530**. Wheels **515** disposed in tracks **530** may thereby allow the wheels **515** to rotate as a single unit, thereby allowing automatic driller **500** better grip and/or stability within the well. The wheels **515** may be formed from various metals, metal alloys, polymers, composites, rubbers, and combinations thereof. For example, in one embodiment, wheels may be formed from a rubber or rubber compound disposed around a metal or polymer frame (not independently shown). Tracks **530** may be formed from various metals, metal alloys, polymers, composites, rubbers, and combinations thereof. In this embodiment, automatic driller **500** is illustrated as having two sets of motive device **510**, however, in other embodiments, automatic driller **500** may have more than two sets of motive devices. For example, automatic driller **500** may have three, four, five, or more sets of motive devices **510** concentrically disposed around tool body **505**. The number of motive devices **510** may depend on the diameter of the well, the operational parameters of automatic driller **500**, and/or the operational requirements for a particular automatic driller **500**.

Automatic driller **500** further includes a drill bit **520** disposed at a distal end **523** of tool body **505**. Various types of drill bits **520** may be used according to embodiments of the present disclosure. Examples of drill bits **520** that may be disposed on tool body **505** include PDC bits. In addition to PDC drill bits, drill bit **520** may also include, but not limited to, a roller cone drill bit.

Drill bit **520** may also be capable of being collapsed within tool body **505**. In such an embodiment, drill bit **520** may be supported by one or more springs (not shown) disposed within tool body **505**. In certain embodiments, rather than springs, alternative mechanical, electrical, hydraulic, pneumatic, or pressurized locking/expandable mechanisms may be used. While collapsed, either entirely or partially within tool body, the spring may be in compression. Upon actuation, the spring may be released, thereby allowing drill bit **520** to expand out of tool body **505**. In certain embodiments, in addition to drill bit **520** being collapsible within tool body **505**, drill bit **520** may be radially compressible. In such an embodiment, in a run-in-hole state, drill bit **520** may have a smaller outer diameter than in an operational state. For example, as automatic driller **500** is run-in-hole, the drill bit may have an outer diameter such that the drill bit **520** may fit partially or entirely within tool body **505**.

During an operational state, the drill bit **520** may be radially expanded, thereby increasing the outer diameter of drill bit **520** to substantially match the inner diameter of a well. In order to radially compress drill bit **520**, one or more springs may hold drill bit **520** in compressed, run-in-state prior to actuation of automatic driller **500**. Release of the springs may thereby allow drill bits **520** to radially expand to an operational state. Those of ordinary skill in the art will appreciate that in other embodiments, drill bit **520** may be collapsed and/or compressed without the use of springs or other mechanically restrictive devices. In such embodiments, drill bit **520** may remain collapsed and/or compressed prior to electrical, pneumatic, or hydraulic actuation of automatic driller **500**. Thus, in certain embodiments, drill bit **520** may remain collapsed and/or compressed prior to a fluid being used to actuate drill bit **520**.

In this embodiment, automatic driller **500** includes two drill bits **520**, a first drill bit **520***a* disposed at a distal end **523** of automatic driller **500** and a second drill bit **520***b* disposed at a proximate end **527** of automatic driller **500**. As illustrated, first and second drill bits **520***a*/**520***b* are substantially the same, however, in other embodiments, first and second drill bits **520***a*/**520***b* may be of different size, geometry, or form. For example, in certain embodiments, first drill bit **520***a* may be a primary drill bit **520**, while second drill bit **520***b* may be a secondary drill bit **520** that is designed to clear obstructions as automatic driller **500** returns to a connector (not shown) to be recharged. In such an embodiment, second drill bit **520***b* may be smaller or otherwise less substantial than first drill bit **520***a*. Additionally, in certain embodiments, the type of drill bit **520** used may differ. For example, in one embodiment, first drill bit **520***a* may be a PDC bit, while second drill bit **520***b* may be a roller cone drill bit. In still other embodiments, first drill bit **520***a* may not have to be compressed or collapsed, while second drill bit **520***b* may have to be compressed or collapsed to allow automatic driller **500** to be recharged. Those of ordinary skill in the art will appreciate that the first and second drill bits **520***a*/**520***b* may vary according to the requirements of a drilling or well cleaning operation.

Automatic driller **500** may also include one or more setting tools **525**. Setting tools **525** may include radially expandable projections that are configured to hold automatic driller **500** in place during operation. Setting tools **525** will be discussed in detail below during discussion of the operation of automatic driller **500**. However, generally, setting tools **525** may be formed from metals, metal alloys, polymers, and or composites, and may be configured to expand from tool body **505** into contact with a well or well casing. The setting tools **525** may include a plurality of teeth (not independently shown) that are configured to grip the inner diameter of the well or well casing, thereby holding automatic driller **500** in a desired position or orientation during automatic driller actuation. In this embodiment, automatic driller **500** includes two setting tools **525**, however, those of ordinary skill in the art will appreciate that in other embodiments, automatic driller **500** may include one, two, three, four, or more setting tools **525**.

Automatic driller **500** may also include various other components that allow automatic driller **500** to operate downhole independently. As discussed above with respect to the automatic packer, automatic driller **500** may include a rechargeable battery (not independently shown), a data controller or a programmable logic controller ("PLC") (not independently shown), a memory storage device (not independently shown), a wireless transmitter or transceiver (not independently shown), and multiple sensors (not independently shown). Examples of sensors that may be included with automatic drill **500** include sensors that may measure a temperature, a pressure, a fluid type, specific gravity spinner, induction, conduction, refraction, infrared, a load, an acceleration, a velocity, a fiber optic signal, an ultrasonic signal, a tachometer measurement, a wireless transmission, a gyroscopic measurement, a casing collar locator, a modular reservoir dynamic test, and/or a position within the well. Generally, those of ordinary skill in the art will appreciate that the sensors may be used to determine a location of the automatic driller **500** within a well, as well as determine whether obstructions may exist within the well. The sensors may also be used to log data or image data for contemporaneous or later processing/viewing. If an obstruction is located, the automatic driller **500** may be actuated in order to clear the obstruction from the well. Additionally, the sensors may be used to determine the location of automatic driller **500** within a well, thereby allowing a secondary borehole to be cut or sidetracked from the well. The operation of automatic driller **500** is discussed in detail below.

Referring to FIG. **30**, a top view of an automatic driller **500** according to embodiments of the present disclosure is shown. In this embodiment, automatic driller **500** is shown having a tool body **505** a drill bit **520** and a plurality of motive devices **510**. In this embodiment, there are four motive devices **510** disposed along the outer diameter of tool body **505**. In other embodiments, more or less than four motive devices **510** may be disposed along the outer diameter of tool body **505**. For example, in certain embodiments, two, three, five, six, or more motive devices **510** may be disposed on the outer diameter of tool body **505**. As explained above, in certain embodiments, motive devices **510** may include wheels and/or tracks.

In this embodiment, automatic driller **500** is illustrated in a run-in-hole condition, as drill bit **520** is collapsed and/or compressed and has an outer diameter that is less than the outer diameter of tool body **505**. Additionally, setting tools **525** are not expanded, thereby allowing the automatic driller **500** to move freely within a well. Those of ordinary skill in the art will appreciate that not all drill bits **520** have to be collapsed and/or compressed in a run-in-hole state. For example, as long as the outer diameter of drill bit **520** is smaller than the inner diameter of the well or well tubular, automatic driller **500** may move freely within a well. However, in certain embodiments it may be advantageous to further decrease the outer diameter of drill bit **520** during run-in-hole conditions to prevent getting stuck or causing unintentional damage to the well.

Referring to FIG. **31**, a top view of an automatic driller **500** according to embodiments of the present disclosure is shown. In this embodiment, automatic driller **500** is shown having a tool body **505** a drill bit **520** and a plurality of motive devices **510**. In this embodiment, there are four motive devices **510** disposed along the outer diameter of tool body **505**. In other embodiments, more or less than four motive devices **510** may be disposed along the outer diameter of tool body **505**. For example, in certain embodiments, two, three, five, six, or more motive devices **510** may be disposed on the outer diameter of tool body **505**. As explained above, in certain embodiments, motive devices **510** may include wheels and/or tracks.

In this embodiment, automatic driller **500** is illustrated setting tools **525** in an actuated condition. In an actuated condition, setting tools **525** may radially expand from tool body **505** into contact with a well wall or well casing. In an expanded condition, the setting tools **525** may thereby stabilize automatic driller **500**, allowing drill bit **520** to clear an obstruction or drill a secondary borehole. Automatic driller **500** is illustrated as having two setting tools **525**, however, in other embodiments, more than two, such as three, four five or more setting tools **525** may be disposed on tool body. Additionally, those of ordinary skill in the art will appreciate that in certain embodiments, not every setting tool **525** may contact the well or well casing during actuation. For example, in certain embodiments only one of two, two of three, etc., may contact the well or well casing.

Referring to FIG. **32** a cross-sectional view of an automatic driller **500** disposed in a well is shown. In FIG. **32**, an automatic driller **500** is shown as it is being disposed in a well **535** in a run-in-hole state. As described above in detail, automatic driller **500** includes a tool body **505** with a plurality of motive devices **510** disposed thereon. Automatic driller **500** also includes a drill bit **520** and setting tools **525**. Automatic driller **500** may also include other various components that are not expressly illustrated. For example, automatic driller **500** may further include a rechargeable battery (not independently shown), a data controller or a programmable logic controller ("PLC") (not independently shown), a memory storage device (not independently shown), a wireless transmitter or transceiver (not independently shown), logging and imaging tools, and multiple sensors (not independently shown). Examples of sensors that may be included with automatic drill **500** include sensors that may measure a temperature, a pressure, a fluid type, specific gravity spinner, induction, conduction, refraction, infrared, a load, an acceleration, a velocity, a fiber optic signal, an ultrasonic signal, a tachometer measurement, a wireless transmission, a gyroscopic measurement, a casing collar locator, logging tools, imaging tools, modular formation dynamic testing tools, a modular reservoir dynamic test, and/or a position within the well.

Automatic driller **500** may initially be run-in-hole on a tubular **540**. Examples of tubulars **540** that may be used include pipe, coiled tubing, wireline, electric line, flat pack, and the like. As such, tubulars **540** may be formed from metal and metal alloys, polymers, composites, and other materials capable of holding and lowering automatic driller **500** into well **535**.

In this embodiment, automatic driller **500** is illustrated being lowered into well **535** on a tubular **540** that has a central conduit **545** through which an electric line **550** may be run. Electric line **550** is configured to connect automatic driller **500** to a surface-based power source **555**. The surface-based power source **555** may include a generator or other electric source capable of providing electricity to automatic driller **500** when automatic driller **500** is connected to tubular **540**. While automatic driller **500** is shown connected to tubular **540**, those of ordinary skill in the art will appreciate that automatic driller **500** may have an electrical input (not independently shown) that is configured to mate with a second electrical input (not independently shown) that is disposed on tubular **540**. The mated first and second electrical inputs may thereby be used to provide power to automatic driller **500**, thereby allowing a power source, such as a battery, of automatic driller **500** to be recharged.

During operation, the power source of automatic driller **500** may be charged or in a charging condition as automatic driller **500** is lowered into the well **535**. During actuation of automatic driller **500**, automatic driller **500** may disconnect from tubular **540**, thereby allowing automatic driller **500** to run off its independent power source. Automatic driller **500** may then complete an operation, which will be discussed in detail below. When automatic driller **500** completes an operation or is otherwise low on power, automatic driller **500** may return and connect to tubular **540**, thereby allowing the power source of automatic driller **500** to be recharged. Because tubular **540** is connected to a surface-based power source **555**, the automatic driller **500** may be recharged numerous times before having to be returned to the surface. Thus, automatic driller **500** may perform multiple operations without requiring tripping of the tubular **540** and automatic driller **500**. In another embodiment the electrical conduit can be connected to the automatic driller at all times, even when it disconnects from the tubular, to have continual charge, receive/transmit data, logging, reprogram, and have the option to control the automatic driller **500** from the surface in real time.

Referring to FIG. **33** a cross-sectional view of an automatic driller **500** disposed in a well is shown. In FIG. **33**, an automatic driller **500** is shown as it is being disposed in a well **535** in a run-in-hole state. As described above in detail, automatic driller **500** includes a tool body **505** with a plurality of motive devices **510** disposed thereon. Automatic driller **500** also includes a drill bit **520** and setting tools **525**. Automatic driller **500** may also include other various components that are not expressly illustrated. For example, automatic driller **500** may further include a rechargeable battery (not independently shown), a data controller or a programmable logic controller ("PLC") (not independently shown), a memory storage device (not independently shown), a wireless transmitter or transceiver (not independently shown), logging tools, and multiple sensors (not independently shown). Examples of sensors that may be included with automatic drill **500** include sensors that may measure a temperature, a pressure, a fluid type, specific gravity spinner, induction, conduction, refraction, infrared, a load, an acceleration, a velocity, a fiber optic signal, an ultrasonic signal, a tachometer measurement, a wireless transmission, a gyroscopic measurement, a casing collar locator, logging tools, imaging tools, modular dynamic testing tools, a modular reservoir dynamic test, and/or a position within the well.

In this embodiment, automatic driller **500** is illustrated being lowered into well **535** on a tubular **540** that may or may not have a central conduit **545**. As such, an electric line **550** is connected to the outer diameter of tubular **540**. In such an embodiment, the electric line **550** may be banded to tubular **540** using, for example, adhesives and/or mechanical connections that hold electric line **550** to tubular **540**. Electric line **550** is configured to connect automatic driller **500** to a surface-based power source **555**. The surface-based power source **555** may include a generator or other electric source capable of providing electricity to automatic driller **500** when automatic driller **500** is connected to tubular **540**. While automatic driller **500** is shown connected to tubular **540**, those of ordinary skill in the art will appreciate that automatic driller **500** may have an electrical input (not independently shown) that is configured to mate with a second electrical input (not independently shown) that is disposed on tubular **540**. The mated first and second electrical inputs may thereby be used to provide power to automatic driller **500**, thereby allowing a power source, such as a battery, of automatic driller **500** to be recharged.

During operation, the power source of automatic driller **500** may be charged or in a charging condition as automatic driller **500** is lowered into the well **535**. During actuation of automatic driller **500**, automatic driller **500** may disconnect from tubular **540**, thereby allowing automatic driller **500** to run off its independent power source. Automatic driller **500** may then complete an operation, which will be discussed in detail below. When automatic driller **500** completes an operation or is otherwise low on power, automatic driller **500** may return and connect to tubular **540**, thereby allowing the power source of automatic driller **500** to be recharged. Because tubular **540** is connected to a surface-based power source **555**, the automatic driller **500** may be recharged numerous times before having to be returned to the surface. Thus, automatic driller **500** may perform multiple operations without requiring tripping of the tubular **540** and automatic driller **500**. Also able to receive or transmit data, reprogram, or test equipment.

Referring to FIG. **34** a cross-sectional view of an automatic driller **500** disposed in a well is shown. As described above in detail, automatic driller **500** includes a tool body **505** with a plurality of motive devices **510** disposed thereon. Automatic driller **500** also includes a drill bit **520** and setting tools **525**. Automatic driller **500** may also include other various components that are not expressly illustrated. For example, automatic driller **500** may further include a rechargeable battery (not independently shown), a data controller or a programmable logic controller ("PLC") (not independently shown), a memory storage device (not independently shown), a wireless transmitter or transceiver (not independently shown), logging tools, and multiple sensors (not independently shown). Examples of sensors that may be included with automatic drill **500** include sensors that may measure a temperature, a pressure, a fluid type, specific gravity spinner, induction, conduction, refraction, infrared, a load, an acceleration, a velocity, a fiber optic signal, an ultrasonic signal, a tachometer measurement, a wireless transmission, a gyroscopic measurement, a casing collar locator, logging tools, imaging tools, modular dynamic testing tools, a modular reservoir dynamic test, and/or a position within the well **535**.

A first type of operation in which automatic driller **500** may be used is an operation intended to clean a portion of a well **535**. In such an operation, automatic driller **500** may disconnect from tubular and move freely within the well **535**. As automatic driller **500** moves within well **535**, the sensors of automatic driller **500** may substantially continuously measure and/or log certain well parameters in order to determine which actuation of drill bit **520** is required in order to clear an obstruction **560**. For example, automatic driller **500** may use sonar in order to determine if there is an obstruction **560** in well **535**. In other embodiments, automatic driller **500** may determine a torque variance that indicates an obstruction **560** is blocking the path of automatic driller **500**. In still other embodiments, proximity sensors may be used to determine an obstruction **560** is blocking the pack of automatic driller **500**. Those of ordinary skill in the art will appreciate that any type of sensor may be used to determine whether an obstruction **560** is blocking the path of automatic driller **500**. The types of sensing discussed herein are merely exemplary in nature and any other method of determining the location of an obstruction **560** may also be used.

Referring to FIG. **35**, a cross-sectional view of an automatic driller **500** disposed in a well is shown. As described above in detail, automatic driller **500** includes a tool body **505** with a plurality of motive devices **510** disposed thereon. Automatic driller **500** also includes a drill bit **520** and setting tools **525**. Automatic driller **500** may also include other various components that are not expressly illustrated. For example, automatic driller **500** may further include a rechargeable battery (not independently shown), a data controller or a programmable logic controller ("PLC") (not independently shown), a memory storage device (not independently shown), a wireless transmitter or transceiver (not independently shown), logging tools, and multiple sensors (not independently shown). Examples of sensors that may be included with automatic drill **500** include sensors that may measure a temperature, a pressure, a fluid type, specific gravity spinner, induction, conduction, refraction, infrared, a load, an acceleration, a velocity, a fiber optic signal, an ultrasonic signal, a tachometer measurement, a wireless transmission, a gyroscopic measurement, a casing collar locator, logging tools, imaging tools, modular dynamic testing tools, a modular reservoir dynamic test, and/or a position within the well **535**.

After an obstruction **560** is determined to be in well **535**, automatic driller **500** may automatically actuate. Actuation of automatic driller **500** may include expanding drill bit **520** into an operational state. In certain embodiments, such as when drill bit **520** is not collapsed or compressed, drill bit **520** may not have to actuate into an operational state. In other embodiments, drill bit **520** may substantially continuously rotate as automatic driller **500** moves through well **535**, thereby negating the need for the drill bit **520** to independently actuate. Regardless of whether a separate actuation step is required in order to facilitate the removal of obstruction **560**, drill bit **520** may begin rotation in order to remove the obstruction **560**.

In addition to actuation of drill bit **520**, one or more setting tools **525** may be deployed. Deployment of setting tools **525** may include radially expanding one or more setting tools into contact with the well **535**. During setting tool **525** deployment, the setting tools may stab into the well **535**, thereby holding automatic driller **500** relatively in place within the well **535**. As discussed above, setting tools **525** may be connected to one or more springs (not independently shown), or other types of mechanical, hydraulic, pneumatic, or pressurized locking mechanisms, thereby allowing automatic driller **500** to move longitudinally within the well **535**, contacting the obstruction **560** multiple times, in order to facilitate drilling. Additionally, setting tools **525** may be used to bias automatic driller **500** in a position such that it can only move one direction within well **535**. For example, when obstruction **560** is located lower in well **535** than automatic driller **500**, setting tools **525** may prevent automatic driller **500** from moving longitudinally upward within well **535**. As such, setting tools **525** may provide a force upon drill bit **520** similar to a weight on bit, which is typically applied in conventional drilling operations. The force applied to drill bit **520** may thereby facilitate the removal of obstruction **560** from the well **535**. In certain embodiments, drill bit **520** may also be used in a pulsating manner to chip away an obstruction. In such a pulsating circumstance, the drill bit **520** may be moved into contact and then out of contact with the obstruction numerous times. Alternatively, the drill bit **520** may be actuated and then unactuated in a pulsating manner in order to clear the obstruction.

After the obstruction **560** is removed, automatic driller **500** may continue downward within well **535** clearing additional obstruction, if present. Additionally, drill bit **520** may be configured to continuously rotate such that if relatively small obstructions, such as sand deposits or other relatively small debris is encountered that might not otherwise cause an actuation operation, the obstruction is passively removed. Additionally, those of ordinary skill in the art will appreciate that relatively small debris may be removed by automatic driller running over, and thus loosening, the debris from the well **535**.

After automatic driller **500** completes an operational cycle, the automatic driller **500** may return to tubular **540**, reconnecting to tubular **540** and recharging its power source. In certain embodiments, automatic driller **500** may be connected to a continuous power source. In such an embodiment, rather than return to tubular **540**, automatic driller may be directed to another job or stay at its current location recording and transmitting data about the environment downhole until it is needed for further jobs. Those of ordinary skill in the art will appreciate that an operational cycle may include a program predefined by automatic driller **500** to clear a portion of a well **535**. In one embodiment, an operational cycle may include clearing a certain distance of a well **535**. In other embodiments, an operational cycle may include moving within a well **535** to a certain position in order to take specific measurements or log a condition within the well. In still other embodiments, an operational cycle may include moving within a well **535** for a specified amount of time, while in still other embodiments, an operational cycle may refer to clearing a well **535** until power source level requires recharging. As such, the automatic driller **500** program may allow automatic driller **500** to operate substantially independently from the surface.

In certain embodiments, automatic driller **500** may be configured to receive additional input from the surface. In such embodiments, a surface operator may send instructions to automatic driller **500** to perform a desired operation. The instructions may be sent through, but not limited to, electric line (**550** of FIGS. **32** and **33**), through other wired connections, or wirelessly. Similarly, automatic driller **500** may send information to a surface operator through, but not limited to, electric line (**550** of FIGS. **32** and **33**), through other wired connections, or wirelessly. As such, automatic driller may be used to perform predefined operations, be instruction downhole, or be reprogrammed to perform different operations without having to trip the automatic driller **500** to the surface for reprogramming.

Referring to FIG. **36**, a cross-sectional view of an automatic driller **500** disposed in a well is shown. As described above in detail, automatic driller **500** includes a tool body **505** with a plurality of motive devices **510** disposed thereon. Automatic driller **500** also includes a drill bit **520** and setting tools **525**. Automatic driller **500** may also include other various components that are not expressly illustrated. For example, automatic driller **500** may further include a rechargeable battery (not independently shown), a data controller or a programmable logic controller ("PLC") (not independently shown), a memory storage device (not independently shown), a wireless transmitter or transceiver (not independently shown), logging tools, and multiple sensors (not independently shown). Examples of sensors that may be included with automatic drill **500** include sensors that may measure a temperature, a pressure, a fluid type, specific gravity spinner, induction, conduction, refraction, infrared, a load, an acceleration, a velocity, a fiber optic signal, an ultrasonic signal, a tachometer measurement, a wireless transmission, a gyroscopic measurement, a casing collar locator, logging tools, imaging tools, modular formation dynamic testing tools, a modular reservoir dynamic test, and/or a position within the well **535**.

In this embodiment, automatic driller **500** is configured with a program to drill a secondary borehole. Secondary boreholes may be drilled in order to explore additional potential downhole reservoirs, as well as to laterally expand a well **535** in a different direction. For example, off of a single primary well **535**, a number of secondary boreholes may be formed in order to reach additional hydrocarbon reservoirs without requiring drilling additional primary wells **535**. Secondary boreholes may vary in inclination. For example, in certain wells **535**, a secondary borehole may vary with a small angle of inclination with respect to the surface, while in certain wells **535**, secondary boreholes may extend at approximately 90 degrees or more with respect to primary well **535**. Additionally, those of ordinary skill in the art will appreciate that the angle of wells **535** vary greatly the deeper and/or longer the well. As such, wells **535** may have unintended angular inclination that may prevent typical downhole tools from moving freely within the well. In such wells **535**, automatic driller **500** may allow sections of wells **535** to be reached that other tools may not be capable of reaching, as automatic driller **500** includes motive device **510**, thereby allowing automatic driller to navigate wells **535** drilled with unintended angular inclination.

In this embodiment, automatic driller **500** is configured to drill a secondary borehole from well **535**. In order to drill a secondary borehole, automatic driller **500** runs a program that actuates drill bit **520**, substantially as described above. Along with actuation of drill bit **520**, automatic driller may also deploy setting tools **525**, however, rather than centralize drill bit **520** within well **535**, setting tools **525** may be used to angle drill bit **520** and/or automatic driller **500** at a desired angle to cut a secondary borehole. In certain embodiments, setting tool **525** alone may angle automatic driller **500** within well **535** at the proper orientation to drill the desired angled secondary borehole. In other embodiments, drill bit **520** may be configured to rotate with respect to the tool body **505**, thereby allowing drill bit **520** to cut at a desired angle with respect to well **535**. In still other embodiments, such as the embodiment illustrated in FIG. **36**, setting tools **535** may be deployed and drill bit **520** may be angled to achieve the desired drilling orientation.

Depending on the parameters of the well, drill bit **520** may be required to cut directly into formation, or alternatively, may be required to cut through casing and/or concrete in order to create the secondary borehole. Those of ordinary skill in the art will appreciate that the type of drill bit **520** used, including the type of cutters on the drill bit **520** may vary according to the well parameters. Additionally, in certain embodiments, fluids may be flowing through the well **535** in order to circulate the cuttings and cool the drill bit **520**. Examples of fluids that may be present in well **535** may include, for example, water, brines, and hydrocarbons. Depending on the flow rate of fluids within the well, as well as drilling speed, additional fluids may be introduced form the surface of the well **535** in order to provide adequate fluid flow across the drill bit **520**.

Referring to FIG. **37**, a cross-sectional view of an automatic driller **500** disposed in a well is shown. As described above in detail, automatic driller **500** includes a tool body **505** with a plurality of motive devices **510** disposed thereon. Automatic driller **500** also includes a drill bit **520** and setting tools **525**. Automatic driller **500** may also include other various components that are not expressly illustrated. For example, automatic driller **500** may further include a rechargeable battery (not independently shown), a data controller or a programmable logic controller ("PLC") (not independently shown), a memory storage device (not independently shown), a wireless transmitter or transceiver (not independently shown), and multiple sensors (not independently shown). Examples of sensors that may be included with automatic drill **500** include sensors that may measure a temperature, a pressure, a fluid type, specific gravity spinner, induction, conduction, refraction, infrared, a load, an acceleration, a velocity, a fiber optic signal, an ultrasonic signal, a tachometer measurement, a wireless transmission, a gyroscopic measurement, a casing collar locator, a modular reservoir dynamic test, and/or a position within the well **535**.

As drill bit **520** cuts through the wall or casing of well **535**, automatic driller **500** may continue drilling a secondary borehole **565**. In order to allow automatic driller **500** to continue drilling secondary borehole **565**, setting tools **525** may be configured to expand in certain directions and drill bit **520** may adjust its angle with respect to tool body **505**, thereby allowing a relatively straight secondary borehole **565** to be drilled.

In addition to setting tools **525** and drill bit **520** being able to orient the automatic driller **500** to a correct angular inclination when drilling secondary borehole **565**, the flexibility of tool body **505** may also facilitate the drilling of secondary borehole **565**. As discussed above, tool body **505** may be formed from a material or through the use of appropriate components such that tool body **505** is capable of flexing. The flexibility of tool body **505** may thereby allow automatic driller **500** to navigate through tight angles, such as those that form when a secondary borehole **565** is initially drilled. For example, in certain embodiments tool body **500** may be configured to flex between 1° and 5° with respect to a central longitudinal axis of automatic driller **500**. In other embodiments, tool body **500** may be configured to flex between 5° and 10° with respect to a central longitudinal axis of automatic driller **500**. In still other embodiments, tool body **500** may be configured to flex greater than 10° with respect to a central longitudinal axis of automatic driller **500**.

Depending on the hardness of the formation or substance being drilled, automatic driller **500** may either continuously drill till a desired depth is reached or may move in and out of the secondary borehole **565** in order to facilitate cutting and cuttings removal. Additionally, those of ordinary skill in the art will appreciate that depending on the type of secondary borehole **565** formed, as well as well parameters, automatic driller **500** may be required to return to tubular **540** periodically in order to recharge. If a recharge cycle is required, the programming of automatic driller **500** may allow automatic driller **500** to return to the secondary borehole **565** after completion of a recharge cycle.

Referring to FIG. **38**, a cross-sectional view of an automatic driller **500** disposed in a well is shown. As described above in detail, automatic driller **500** includes a tool body **505** with a plurality of motive devices **510** disposed thereon. Automatic driller **500** also includes a drill bit **520** and setting tools **525**. Automatic driller **500** may also include other various components that are not expressly illustrated. For example, automatic driller **500** may further include a rechargeable battery (not independently shown), a data controller or a programmable logic controller ("PLC") (not independently shown), a memory storage device (not independently shown), a wireless transmitter or transceiver (not independently shown), and multiple sensors (not independently shown). Examples of sensors that may be included with automatic drill **500** include sensors that may measure a temperature, a pressure, a fluid type, specific gravity spinner, induction, conduction, refraction, infrared, a load, an acceleration, a velocity, a fiber optic signal, an ultrasonic signal, a tachometer measurement, a wireless transmission, a gyroscopic measurement, a casing collar locator, a modular reservoir dynamic test, and/or a position within the well **535**.

After secondary borehole **565** is substantially opened to the desired angular inclination, automatic driller **500** may be configured to return to a normal drilling pattern, whereby drill bit **520** is aligned with tool body **505** and/or setting tools **525** are deployed to keep drill bit **520** concentric within the secondary borehole **565**.

While the automatic driller **500** discussed above is limited to a discussion of a drill bit **520** that is run on electrical power, in other embodiments, drill bit **500** may be run on various other types of power. For example, in one embodiment, automatic driller **500** may actuate drill bit **520** using pressure, such as fluids e.g., gases. The fluids may be used to articulate a drive shaft of drill bit **520**, thereby causing drill bit **520** to rotate relative to tool body **505**. In other embodiments, automatic driller **500** may actuate drill bit **520** using a hydraulic pressure, such as hydraulic fluids. The hydraulic fluids may cycle between high pressure and low pressure tanks. Hydraulic fluid from the high pressure tank may thus be used to articular a drive shaft of the drill bit **520**, thereby rotating the drill bit **520** with respect to the tool body **505**. In still other embodiments, drill bit **520** may be actuated using mechanical mechanisms, such as one or more springs connected to drill bit **520**. In such an embodiment, one or more springs may be connected to a drive shaft of drill bit **520**. Prior to drilling, one or more of the springs may be compressed and while drilling, the springs may be put in tension, thereby imparting a rotational force to the drive shaft and rotating drill bit **520** with respect to tool body **505**. In an embodiment using springs, multiple springs may be used, such that when one spring is in compression, one or more other springs may be in tension, thereby substantially continuously rotating the drive shaft of drill bit **520**. Those of ordinary skill in the art will appreciate that additional methods of actuating drill bit **520** may also be used and are within the scope of the present disclosure.

Advantageously, embodiments of the present disclosure may allow for the automated setting of packing elements within wells. More specifically, embodiments of the present disclosure may allow an operator to determine where within a well a packer is to be set and deploy the packer directly into the well. Because the packer is deployed directly into the well, expensive and time consuming running tools may be avoided. For example, automatic packers according to embodiments disclosed herein may be released freely into the wellbore without the aid of tubing or wireline. Upon falling to a desired location within the well, the automatic packers may actuate without further signal from the surface. Embodiments disclosed herein may also provide an automatic packer that may temporarily isolate a portion of the well, gather data through sensors, and then release and return to the surface. The automatic packer may return to the surface through natural flow of the well or through the use of wireline or other motive means.

Referring to FIG. **39**, a block diagram of an automatic driller according to embodiments of the present disclosure is shown. Automatic driller includes a programmable logic controller (PLC) **570** and may be connected to or otherwise include memory **575** and one or more microprocessors **580**. PLC **570** may be connected to various operational component sub-systems. Those of ordinary skill in the art will appreciate that in certain embodiments not all of the sub-systems may be present, while in other embodiments, all of the sub-systems, or a combination of various sub-systems may be present. Furthermore, in certain embodiments, additional sub-systems in addition to those expressly discussed here may be present.

In certain embodiments, PLC **570** may be connected to one or more sensors or sensor assemblies **585**. Examples of sensors **585** that may be present include sensors **585** to measure a temperature, a pressure, a fluid type, specific gravity spinner, induction, conduction, refraction, infrared, a load, an acceleration, a velocity, a fiber optic signal, an ultrasonic signal, a tachometer measurement, a wireless transmission, a gyroscopic measurement, a casing collar locator, logging tools, imaging tools, modular formation dynamic testing tools, a modular reservoir dynamic test, and/or a position within the well. The sensors **585** may be connected directly to PLC **570** or may be connected to various other sub-systems in order to provide data to the sub-systems.

PLC **570** may also be connected to a power supply sub-system. The power supply sub-system may include a power supply **590**, such as a battery. Power supply **590** may be connected to a battery recharge system **595**. The battery recharge system **595** may include various components that allow power supply **590** to be recharged, either substantially continuously or through external components. In certain embodiments, one or more of the power supply **590** and the battery recharge system **595** may be connected to an external power source, thereby providing the automatic driller a substantially continuous power supply. In other embodiments, battery recharge system **595** may include one or more of components to recharge power supply **590** by downhole heat induction, flowing phases through a turbine or turbine blades, kinetic recharging, movement, etc.

PLC **570** may also be connected to one or more logging tools **600**. Examples of logging tools may include tools that provide electrical logs, porosity logs, lithology logs, logging while drilling, memory logs, and various other types of logs. Specific examples of the types of devices that may be used to log conditions downhole include gamma ray logging, spontaneous potential logging, resistivity logging, density logging, sonic logging, caliper logging, mud logging, nuclear magnetic resonance logging, neutron porosity logging, image logging, and the like. The logged data may be stored in the logging tools **600**, sent to the PLC **570** for further processing, or otherwise sent to the surface for analysis.

PLC **570** may also include a data download/transfer tool sub-system **605**. The data download/transfer tool sub-system **605** may include devices that allow for the automatic driller to interact with other tools, either downhole or at the surface. For example, in certain embodiments, automatic driller may return data collected downhole to the surface while automatic driller is still downhole. In such a circumstance, the transfer tool **605** may interface with a wire or other electrical conduit, thereby allowing the automatic driller to return information collected to the surface. Similarly, transfer tool **605** may be used to provide automatic driller instructions from the surface without the need to remove the automatic driller from the well. In still other embodiments, data download/transfer tool sub-system **605** may include wireless connections, thereby allowing the automatic driller to transfer information wirelessly to the surface.

PLC **570** may also be connected to various tool actuation sub-systems, such as drilling bit actuation **610**, automatic driller setting/release mechanisms **615**, motive device systems **620**, and other device systems **625**. The PLC **570** may provide instructions that are either received from the surface or stored in the memory **575** to control one or more of the actuation sub-systems. For example, PLC **570** may include instructions for actuating a drill bit or deactivating a drill bit. The PLC **570** may further include instructions for setting or releasing the automatic driller, instructions for controlling the motive aspects of the automatic driller, or for actuating or deactivating various other devices of the automatic driller. Examples of other aspects of the automatic driller that may be controlled using the PLC **570** may include sensor actuation, logging actuation, packer device actuation, etc.

Advantageously, embodiments of the present disclosure may allow for substantially automated perforation operations to be completed within wells. Upon isolation of a section of a well, an extendable perforator may be released from an automatic packer. The extendable perforator may then longitudinally expand within the well bore, spacing charges as the extendable perforated extends. Upon signal from the surface, based on timing, or based on the fulfillment of predefined criteria, the perforator may be discharged, thereby perforating the well.

Advantageously, embodiments of the present disclosure may allow for packers to be automatically set based on a number of measured criteria. For example, sensors on the automatic packer may measure a temperature, a pressure, a fluid type, a load, an acceleration, a velocity, a tachometer measurement, a casing collar locator measurement, a modular reservoir dynamic test measurement, and/or a position. When a predefined criteria is met, e.g., a density, specific gravity, induction, conduction, refraction, infrared, a specific temperature, fluid type, load, acceleration, velocity, a tachometer measurement, a casing collar measurement, a modular reservoir dynamic test measurement, and/or position is measured, the packer may be set to automatically actuate.

Advantageously, embodiments of the present disclosure may provide for one trip isolation and perforation of sections of a well. Because the perforator is extendable from the packer, after actuation of the packer, perforation may occur without running a separate perforator into the well.

Advantageously, embodiments of the present disclosure may provide for one trip isolation and perforation of single and multiple sections of a well that will help assist on fracture or treatment jobs of a well. Because the perforator is extendable from the packer, after actuation of the packer, perforation may occur without running a separate perforator run into the well and may be able to continue fracturing multiple stages by perforating and isolating each stage with minimal downtime. Such a one trip system may thus increase efficiency and reduce cost.

Also advantageously, embodiments of the present disclosure may provide for one trip isolation and perforation systems that allow for actuation of devices in a section of a well. Such devices may thus be capable of isolating deviated and lateral parts of a well by having a tractor or mobile device that may take the devices to the depth required.

Advantageously, embodiments of the present disclosure may provide for one trip isolation, perforation, data recordation, transmission of data to surface, release of packer, and removal of the packer at the surface of a well. Additionally, apparatuses disclosed herein may provide devices that can temporarily or permanently isolate, perforate, gather data and recover packer by automatic control and or wireless commands.

Advantageously, embodiments of the present disclosure may provide for a substantially self-acting driller to be disposed in a well in order to facilitate clearing obstructions from a well that may decrease production efficiency.

Advantageously, embodiments of the present disclosure may provide for a self-acting driller to be disposed in a well in order to drill secondary boreholes without control from a surface operator.

Advantageously, embodiments of the present disclosure may provide for an automatic downhole tool that can receive programming from the surface by wire or wirelessly and execute the program downhole without additional surface control.

Advantageously, embodiments of the present disclosure may provide for an automatic driller that, once downhole, does not require a return trip to the surface to recharge. Because the automatic driller does not require tripping and can recharge while downhole, the process of cleaning a well of obstructions may be more efficient and may occur on a more frequent basis. Advantageously, the return of the automatic driller to the surface may include collapsing one or more components of the automatic driller and returning the automatic driller to the surface using, for example, wireline or a pressure differential within the well.

While the present invention has been described with respect to the above-noted embodiments, those skilled in the art, having the benefit of this disclosure, will recognize that other embodiments may be devised that are within the scope of the invention as disclosed herein. Accordingly, the scope of the invention should be limited only by the appended claims.

What is claimed is:

1. An automatic drilling apparatus comprising:

a tool body;

a motive device connected to the tool body;

a drill bit connected to the tool body;

a setting tool connected to the tool body and independent of the motive device;

at least one sensor disposed on the tool body; and

a computer disposed in the tool body, wherein the computer is configured to independently actuate the motive device, the drill bit, the setting tool, and the at least one sensor.

2. The automatic drilling apparatus of claim **1**, further comprising a power source disposed in the tool body and connected to the computer.

3. The automatic drilling apparatus of claim **2**, further wherein the power source is rechargeable through kinetic recharging.

4. The automatic drilling apparatus of claim **1**, wherein the sensor is configured to measure at least one of a temperature, a pressure, a fluid type, a load, a density, a specific gravity, an induction, a conduction, a refraction, an infrared signal, a fiber optic signal, an acceleration, a velocity, a wireless transmission, a gyroscopic measurement, an ultrasonic signal, a tachometer measurement, a casing collar locator, a logging tool, a imaging tool, a modular formation dynamic testing tool, and a modular reservoir dynamic test.

5. The automatic drilling apparatus of claim **1**, further comprising a second drill bit disposed at an opposite end of the tool body from the drill bit.

6. The automatic drilling apparatus of claim **1**, wherein the drill bit is collapsible within at least a portion of the tool body.

7. The automatic drilling apparatus of claim **1**, wherein the drill bit is compressible within at least a portion of the tool body.

8. The automatic drilling apparatus of claim **1**, wherein the automatic drilling apparatus is configured to connect to an electric wire that provides electricity from the surface of a well to the automatic drilling apparatus.

9. The automatic drilling apparatus of claim **1**, wherein the automatic drilling apparatus is configured to recharge by movement, heat, or fluid/phase flow through turbine blades.

10. The automatic drilling apparatus of claim **1**, wherein the automatic drilling; apparatus is configured to recharge at the surface.

11. The automatic drilling apparatus of claim **1**, wherein the motive device comprises a track.

12. The automatic drilling apparatus of claim **1**, wherein the drill hit is configured to sidetrack a secondary borehole in a well.

13. The automatic drilling apparatus of claim **1**, wherein the motive device comprises wheels.

14. The automatic drilling apparatus of claim **1**, wherein the tool body is configured to flex during operation to conform to a profile of a well.

15. The automatic drilling apparatus of claim **14**, wherein the tool body is configured to flex between 1 and 5 degrees of a central longitudinal axis of the automatic driller.

16. The automatic drilling apparatus of claim **1**, wherein the drill bit is a radially expandable drill bit.

17. The automatic drilling, apparatus of claim **1**, further comprising at least two motive devices, wherein the two motive devices are configured to move the automatic drilling apparatus within a wellbore.

18. The automatic drilling apparatus of claim **1**, wherein the setting tool comprises radially expandable portions that are unexpanded in a run-in-hole state.

19. The automatic drilling apparatus of claim **1**, wherein the setting tool is configured to angle the automatic drilling apparatus to a specified angle.

20. The automatic drilling apparatus of claim **1**, wherein the setting tool comprises radially expandable projections.

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